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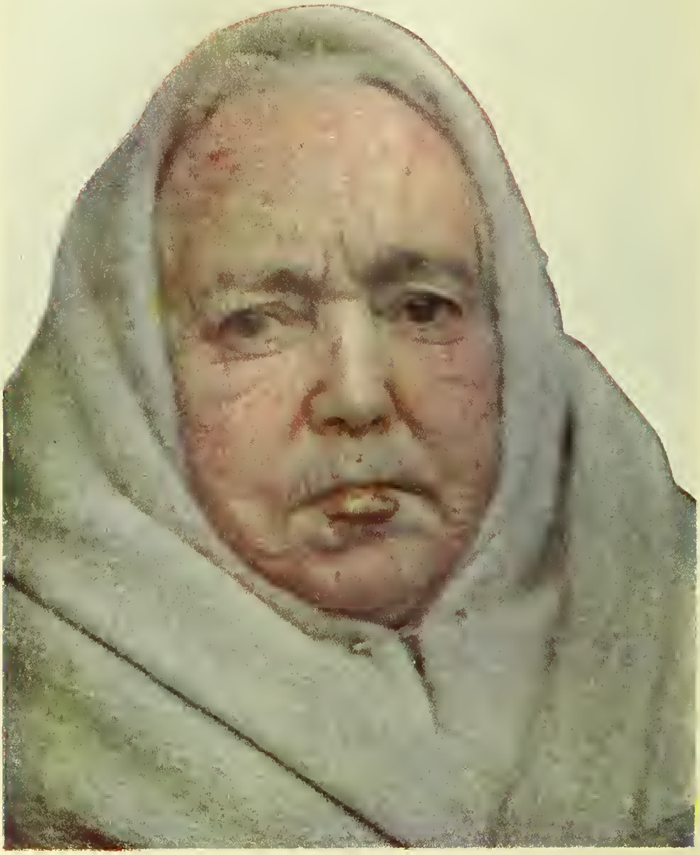

Epithelioma of Lip.

Lumiere colored photograph of a patient in the author's service at the Roosevelt Hospital.

A

TEXT-BOOK OF SURGERY.

FOR STUDENTS AND PRACTITIONERS.

BY

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AND 14 PLATES IN COLORS AND MONOCHROME

SECOND EDITION, THOROUGHLY REVISED AND MUCH ENLARGED.

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TO

ROBERT F. WEIR, M.D., Hon. F.R.C.S. Eng.,
PROFESSOR OF SURGERY, COLUMBIA UNIVERSITY, ETC.,

A MASTER OF SURGERY, A SCHOLARLY TEACHER, A SUCCESSFUL
PRACTITIONER, MY HONORED CHIEF AND
VALUED FRIEND,

THIS VOLUME IS AFFECTIONATELY DEDICATED

BY THE AUTHOR.

603879

PREFACE TO THE SECOND EDITION.

In the interval which has elapsed since the publication of the first edition of this work, so much has been added to our knowledge of surgery that a very thorough revision was necessary to bring it up to date. In making this revision the author also realized that in the former edition the effort to condense was carried too far, as many important subjects were treated too briefly, and some others, perhaps equally important, were omitted. While the aim still is to keep the book in the class of those which may be said to occupy a position midway between the brief manuals and the more voluminous treatises, it has been necessary to add some two hundred pages, in order to present the various subjects more evenly and thoroughly, and to record the important facts in pathology, diagnosis, and treatment to be gleaned from the immense amount of original investigation which has rendered the period spanned by the first edition so noteworthy in the progress of surgery.

Among the new illustrations, there have been introduced a number of colored photographs of gross lesions, taken by the Lumière process. These, it is believed, more accurately represent the appearance of the fresh specimens than any other form of illustration.

The author desires to acknowledge his indebtedness to Dr. Norman R. Ditman, Instructor in Pathology at the College of Physicians and Surgeons and Assistant Pathologist at the Roosevest Hospital, for his assistance in revising the chapters on Surgical Pathology. In these chapters an effort has been made to present the practical rather than the purely scientific side of the subject, and in the illustrations used we have endeavored to introduce an increased number which show the gross pathological picture, rather than that of the microscopical slide.

The author also desires to acknowledge the courtesy of those of his professional associates who have allowed him to reproduce illustrations and original drawings.

G. E. B.

New York, 1909.

CONTENTS.

CHAPTER I.

PAGE
INFECTION CONSIDERED IN ITS SURGICAL RELATIONS 17–32

CHAPTER II.

INFLAMMATION 33–41

CHAPTER III.

ACUTE INFECTIOUS SURGICAL DISEASES 42–63

CHAPTER IV.

CHRONIC INFECTIOUS SURGICAL DISEASES 64–80

CHAPTER V.

TUMORS 81–105

CHAPTER VI.

SHOCK AND ALLIED CONDITIONS 106–125

CHAPTER VII.

SURGICAL TECHNIC 126–154

CHAPTER VIII.

ANÆSTHESIA 155–169

CHAPTER IX.

INJURIES AND DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUES 170–195

CHAPTER X.

INJURIES AND DISEASES OF THE HEART, PERICARDIUM, AND BLOODVESSELS 196–229

CHAPTER XI.

PAGE
INJURIES AND DISEASES OF THE LYMPHATIC SYSTEM 230-244

CHAPTER XII.

INJURIES AND DISEASES OF THE MUSCLES, TENDONS, AND BURSÆ 245-256

CHAPTER XIII.

INJURIES AND DISEASES OF THE NERVES 257-279

CHAPTER XIV.

INJURIES AND DISEASES OF THE BRAIN AND SPINAL CORD . 280-311

CHAPTER XV.

INJURIES AND DISEASES OF THE HEAD, FACE, AND NECK; ORAL, NASAL, AND PHARYNGEAL CAVITIES 312-376

CHAPTER XVI.

INJURIES AND DISEASES OF THE THORAX, PLEURA, AND LUNG. 377-398

CHAPTER XVII.

DISEASES OF THE MAMMARY GLAND 399-414

CHAPTER XVIII.

INJURIES OF THE ABDOMEN 415-421

CHAPTER XIX.

DISEASES OF THE ABDOMEN 422-507

CHAPTER XX.

INJURIES AND DISEASES OF THE KIDNEY AND URETERS . . 508-552

CHAPTER XXI.

INJURIES AND DISEASES OF THE BLADDER AND URETHRA . 553-594

CHAPTER XXII.

INJURIES AND DISEASES OF THE PENIS AND SCROTUM 595-604

CHAPTER XXIII.

DISEASES OF THE TESTICLE, SEMINAL VESICLE, AND PROSTATE. 605-630

CHAPTER XXIV.

PAGE
DISEASES OF THE RECTUM 631–649

CHAPTER XXV.

DISEASES OF BONE 650–668

CHAPTER XXVI.

INJURIES AND DISEASES OF THE JOINTS 669–700

CHAPTER XXVII.

FRACTURES 701–771

CHAPTER XXVIII.

DISLOCATIONS 772–809

CHAPTER XXIX.

HERNIA 810–835

CHAPTER XXX.

AMPUTATIONS 836–856

CHAPTER XXXI.

DEFORMITIES AND THEIR CORRECTIONS 857–875

SURGERY.

CHAPTER I.

INFECTION CONSIDERED IN ITS SURGICAL RELATIONS.

INTRODUCTION.

Surgery is that branch of the healing art directed toward the remedying of injuries, deformities, and other morbid conditions by mechanical operations.

Such a conception of surgery differentiates it sharply from the art of medicine. So intimately related, however, are the two that it is almost impossible to draw a sharp dividing line between them. Therefore, in the broader sense, surgery may be said to include the subjects of infection, inflammation, injuries, new growths, foreign bodies, malformations, deformities, and the relief of pain, with the various methods of operative and therapeutic procedure which their betterment entails.

The phenomena of infection and inflammation, occurring, as they do, more commonly than all others in surgery, being of fundamental importance and far reaching in their relations to other surgical aspects, it is essential that any exposition of the subject of surgery must be preceded by a thorough comprehension of these phenemona.

Although the occurrence of inflammation is often aided by the existence of predisposing agencies, the direct or exciting causes are usually to be found under the heads, direct violence and physical irritation, chemical irritants, and micro-organisms.

Micro-organisms are distributed widely in air, soil, and water, but it is among the habitations of man, where the conditions for their growth and development are especially suitable, that they are most numerous. For the most part, they are harmless species; but pathogenic forms may occasionally be found, especially in localities where the discharges of diseased animals have been allowed to collect. Thus, while the conditions here are unfavorable for the growth of most harmful species, it has been shown that certain pathogenic bacteria have their primary habitat in soil;

while others are capable, at any rate during part of their existence, of finding a suitable nidus there.

So far as we know, then, with few exceptions, micro-organisms whose natural habitat is in the soil, air, or water, are not under normal conditions harmful to man, for they are present in greater or less numbers upon the exposed cutaneous or mucous surfaces of the body, sometimes serving useful functions, as do those in the intestines.

Experiments by Nuttall and Schottelius show that the healthy animal is born germ-free. At birth, however, it is at once introduced into a world of bacteria that fall upon the skin and gain entrance to the respiratory passages and alimentary canal through air and food. In a short time they may be found in various parts of the body, so that each part ultimately becomes a regular habitat for a number of species.

Notwithstanding, however, the occurrence of bacteria in these situations in great numbers, they do not often gain entrance into the body tissues, so that under normal conditions the blood and viscera have been considered germ-free. It has, however, been urged by Adami and Ford that bacteria reach not alone the deeper structures of the intestine under what appear to be normal conditions, but commonly also invade the blood of the portal circulation and the liver and kidneys during life.

Whenever bacteria do find their way into the body, the conditions are usually so unsuitable for their existence that they are soon destroyed. Against such incursions the body is guarded in various ways. Of the defensive arrangements which normally exist at the various portals of entry, some are partly mechanical by reason of the anatomic structure of the part. Thus the thick cutaneous covering is impenetrable to most bacteria; the same is equally true for the stratified squamous layer of the mouth, œsophagus, and vagina. While the cylindric epithelium covering other mucous surfaces is doubtless less efficient, it should be remembered that they are so situated as to be less exposed to injury.

There are certain situations, such as the tonsils and lymphatic apparatus of the gut, which are especially liable to bacterial invasion on account of their delicate covering, but there is abundant reason to suppose, as will be seen shortly, that they are endowed with vital protective properties.

In addition to these mechanical defences are the antibacterial qualities of the secretions on mucous surfaces. Some of the properties depend on the chemical action of the gastric juice; some partly on the antagonism offered to invaders by the normal flora of the part; while still others depend largely upon the germicidal qualities of the secretion.

But notwithstanding these protective factors, bacteria do sometimes penetrate the normal body coverings, and this may especially occur whenever they are injured, even if ever so slightly. Having overcome the external defensive barriers, they usually are arrested or destroyed in the adjoining lymph-nodes. In a most suggestive article Manfredi brings forward sufficient evidence to show that protection by lymphoid tissue occurs in three ways: by filtration of the bacteria, by an attenuation of the virulence of the micro-organisms that reach them, and by the whole body obtaining a greater or less immunity while the first two processes are in operation.

If bacteria do reach the blood, they again have to contend with the body fluids and leucocytes. It is evident that in health the body is protected abundantly against ordinary bacterial invasion, but there are conditions in which the strongest and healthiest body is unable to offer adequate resistance; obviously, therefore, it is usually when the vital resistance of the body cells has been lowered that bacteria overcome the natural safeguards to infection.

PORTALS OF ENTRY.

Bacteria may gain entrance to the body tissues in several different ways. According to the portal of entry, differences not only in the susceptibility of the host but also in the lesions and symptoms of the disease will be noted. Most of the surgically important bacteria may gain entrance through any portal and induce infection in any part of the body, but some are restricted to certain modes of entrance, as in the case of the tetanus bacillus. For the most part, micro-organisms reach the interior of the body from the skin and mucous surfaces. It is very improbable that bacteria present upon the skin can penetrate this tissue when uninjured. It is true, however, that often they appear to reach the interior of the body from what seems to be an uninjured skin surface, but in these cases it is probable that the skin injury has been overlooked by reason of its smallness. It is only very rarely that bacteria directly gain entrance into the general blood-current. They ordinarily reach it through the atria, which have been mentioned.

Animal experiments show that the portal of entry and the channel of infection bear a more or less direct relation to the severity of the infection which follows their entrance. For instance, subcutaneous inoculations into animals are usually much less severe in their results than those made directly into the peritoneal cavity or general vascular system.

External Sources.—The bacteria derived from without the body are those chiefly concerned in the infection of wounds and many other primary surgical infections. If pathogenic bacteria can be kept out of an external wound, no suppuration of the wound ordinarily occurs. They usually gain access to wounds through contact with infected objects. Air infection is relatively unimportant, and here the bacteria usually occur as clumps attached to particles of dust, so that in a perfectly quiet atmosphere, as in a closed room, these particles containing bacteria rapidly settle upon underlying objects. It is a well-known fact that particles including bacteria are not detached from moist surfaces even by strong currents of air.

All the bacteria of surgical importance have been isolated from air and dust, particularly from the dust of hospitals, where they are especially frequent.

Among those of surgical importance which are conveyed through external objects are Streptococcus pyogenes, Staphylococcus pyogenes aureus, Staphylococcus pyogenes albus, Bacillus coli communis, Bacillus pyocyaneus, Bacillus proteus, Diplococcus lanceolatus, Bacillus anthracis, Bacillus tetani, Bacillus aërogenes capsulatus, Bacillus tuberculosis, Micrococcus gonorrhœa, and a host of others.

The relation of insects to the spread of infectious agents has recently been emphasized by Nuttall. Considerable evidence has been accumulated in the past few years which clearly indicates that insects may not only carry from place to place disease-producing micro-organisms, but they may also be concerned, directly or indirectly, in the inoculation of pathogenic micro-organisms.

Interesting experiments made by Schimmelbusch and others studying the rapidity of absorption of bacteria in wounds, show that they are absorbed within a very short time by lymph and blood-vessels from fresh bleeding wounds. Further, it has been shown that so soon as a coagulum has been formed on the surface of a wound the conditions are changed, and particles like bacteria are no longer quickly transported into the blood and lymph circulation. The surface of a healthy granulating wound affords great resistance to bacterial invasion, almost as much as an intact exposed surface of the body. Slight injuries, however, such as probing, removing the dressing, and other manipulations which may convert the granulating wound into a fresh wound, favor the absorption of bacteria.

Bacteria of the Skin.—Since the skin is exposed to contamination from the air and other sources, it is evident that there is scarcely any limit to the number of bacterial species which may be found upon cutaneous surfaces. Most of the organisms ordinarily found are such as may be found in the air or upon external objects. They are principally cocci, but there are great variations in different cases as to the kind and numbers. Sometimes one species far outnumbers the rest. The conditions are not, however, generally favorable for considerable growth of bacteria on the healthy skin, but under the nails and in situations where moisture collects there may be extensive bacterial development. Further, the kind and number of bacteria found upon exposed parts of the skin vary considerably according to the habits and occupation of the individual. Certain organisms which are met with only exceptionally in most persons, are found commonly on the hands of persons who handle or come into proximity with infected cases.

For many of the facts relating to the bacteriology of the skin we are indebted to Welch, who not only called attention to the inconstant characters of the bacteria of the skin but also insisted upon the great regularity with which Staphylococcus epidermidis albus may be obtained in cultures taken from the skin, so that this organism may be regarded as a normal habitant in this situation. It is also regularly present in the layers of epidermis along hair-shafts deeper than can be reached by any practical means of cutaneous disinfection. After complete sterilization of cutaneous surfaces, so that scrapings are sterile, the presence of this white coccus can still be demonstrated on sutures passed through the skin and in excised pieces of skin.

Staphylococcus epidermidis albus is usually innocuous. It is frequently present in aseptic wounds of the skin without inducing suppuration or any untoward reactions. However, it may be the cause of disturbances charaterized especially by elevation of temperature and moderate suppuration. It is a common excitant of stitch abscess. Among other bacteria which may be present upon the skin are Streptococcus pyogenes, Staphylococcus pyogenes aureus and albus, Bacillus pyocyaneus, and Bacillus coli communis.

Skin contaminated with the soil, which, as is well known, contains in many situations abundant bacilli of tetanus and of malignant œdema, is likely to contain these bacteria. This contamination, of course, relates especially to the hands and in the case of those who go barefoot or have holes in their shoes.

The smegma bacillus may be considered in connection with skin bacteria. This organism is usually present in the smegma and may be found about the perineum. Attention is called to it particularly on account of its resemblance in morphology and tinctorial reactions to the tubercle bacillus. It has been mistaken for Bacillus tuberculosis in the examination of urine and of secretions and exudates from the external genitals and the anus. Although smegma bacilli are found to be present with pathogenic bacteria in lesions about these parts, they do not possess pathogenic activities for man.

Many bacteria are attached to the hair, and particles containing bacteria may readily be deposited from the hair upon wounds. They are, for the most part, identical with those found on the skin.

Internal Sources.—The way is open for the access of bacteria into mucous membranes which cover parts which communicate with the outer world through the external orifices of the body. The relatively favorable conditions here present for bacterial growth are counteracted in large part by various mechanical and chemical influences which prevent the survival of most bacteria which may enter. There are, however, many bacteria which may multiply or persist for a long time, particularly those of the alimentary canal and of the upper respiratory tract. Among this number there are some which may be pathogenic, but which under ordinary circumstances are not harmful.

Mouth and Pharynx.—Although the conditions in the mouth and throat are more favorable for the prolonged existence of many bacteria than upon other exposed mucous membranes, very few of the large number which reach these parts persist there. Most of them either pass into the stomach and intestines or are destroyed in the mouth. Most of those present in the mouth and pharynx are saprophytes, some of which have been associated with dental caries.

The following pathogenic bacteria have also been found repeatedly in the healthy mouth: Streptococcus pyogenes, Staphylococcus pyogenes aureus, Staphylococcus pyogenes albus, Micrococcus tetragenus, Diplococcus lanceolatus, Bacillus pneumoniæ of Friedländer, Bacillus coli communis, Bacillus diphtheriæ, Bacillus proteus, and others. The mouth and adjacent parts are the most frequent portals of entry of the organism of actinomycosis; it is especially liable to lodge in or near carious teeth.

Respiratory Passages.—With inspiration, bacteria of air reach the upper respiratory tract. Thompson and Hewlet estimate that from fifteen hundred to fourteen thousand bacteria are inspired every hour, the great majority of which are arrested in the nasal cavities.

Among the pathogenic organisms which have been found in the nasal cavities may be mentioned the common pyogenic cocci, Diplococcus lanceolatus, Meningococcus, Bacillus diphtheriæ, Bacillus tuberculosis, Bacillus aërogenes capsulatus, and Friedlander's pneumobacillus. The presence of capsulated bacilli in the nose is of considerable interest, for organisms of this class have been found with especial frequency in cases of ozena.

Bacteria may be present in the larynx and bronchi in health, but in small numbers. Usually the healthy lung is considered sterile.

Stomach and Intestines.—Under ordinary conditions of life bacteria make their appearance shortly after birth in all parts of the digestive tract. In many animals Bacillus coli communis, or its near allies, seems to be, as in man, the chief obligatory form.

The relative numbers of Bacillus coli communis in different portions of the alimentary canal have been variously estimated. The observations of Gilbert and Dominici and those of Cushing and Livingwood indicate that there is a gradual rise in the number from the duodenum to the ileocecal valve, at which situation the maximum is noted. When the large bowel is reached, there is a marked diminution in the number.

The main sources of the bacteria of the stomach and intestines are the ingesta and air. From these sources great numbers and varieties are introduced into the alimentary canal, but, as is true of exposed mucous surfaces, only a limited number of species are capable of prolonged existence here. The gastric juice may kill many of those which enter the stomach, but there are many which resist its action. Indeed, some can grow in the human stomach. Emphasis has been laid upon the presence of the Boas-Oppler bacillus on account of its supposed diagnostic value in carcinoma of the stomach, but its presence has been shown to depend upon conditions more common in other gastric diseases.

The variety of bacteria in the intestines is large ; the presence of some is only accidental or transient, while others are there with such frequency as to merit special notice. The colon bacillus has already been referred to. Pyogenic cocci are rarely absent from the intestines, where they may be present in such small numbers as to escape detection, but the great frequency with which they may be found in perforative peritonitis is significant. Bacillus proteus, Bacillus pyocyaneus, Bacillus tetani, Diplococcus lanceolatus, Bacillus aërogenes capsulatus, and others have also been found. Much attention has lately been devoted to the presence in the normal intestine of "acid-staining" bacilli having tinctorial reactions similar to those of the tubercle bacillus. That many cases of tuberculous infection have their origin in tubercle bacilli from this source has been clearly demonstrated.

Under normal conditions the intestinal bacteria are found only a short distance in the common bile-duct ; but any alteration from the normal, such as mechanical impediment to the outflow of bile, change in the composition of the bile, or other perturbation in the physiology of secretion, may be followed by an ascending infection of the ducts or gall-bladder. Contrary to the old idea, the bile has not been found to possess any decided bactericidal property. The relation of the origin of many cases of cholecystitis and cholelithiasis to this form of infection by the colon and typhoid bacilli has been firmly establised.

Genito-urinary Tract.—It has been shown repeatedly that the anterior portion of the healthy male urethra contains bacteria. These are abundant and varied in the fossa navicularis, and diminish rapidly in number and kind toward the posterior part of the urethra. Urethral bacteria are usually present in urine voided after sterilization of the meatus and fossa, even in the urine passed toward the end of micturition. Among the non-pathogenic and pathogenic bacteria found in healthy urethras may be mentioned the smegma bacillus, Bacillus coli communis, and the so-called pseudogonococcus. The latter is of importance in reference to the diagnosis of gonorrhœa by microscopic examination. If, however, the morphology, staining reactions, and enclosure and arrangement within cells characterizing the gonococcus be observed, a mistake in diagnosis is possible in only a small number of cases.

It cannot be said that the question has definitely been settled as to whether the bacteria of cystitis are usually those normally present in the urethra or those directly introduced from the meatus. The bladder urine in health is germ free.

The female urethra contains micro-organisms, and the anatomic conditions are much more favorable than in the male for their passage into the bladder. The vagina also contains bacteria in varying number and kind. Pathogenic species are found only occasionally. The so-called "vaginal saprophytes" are the bacteria more constantly present and are evidently harmless. The occasional presence of pathogenic organisms is usually transitory; they may, however, persist for a variable time as harmless parasites. The experiments of Schluter and Witte on the effect of acid on certain bacteria, including pyogenic streptococci and staphylococci, show that the percentage of acid usually present in the vagina may inhibit their growth. Experiments by Kronig and Menge show that bacteria when introduced into the vagina disappear in a relatively short time. Irrigation of the vagina with water or with antiseptics retards the time of their disappearance.

The body of the healthy uterus is ordinarily free from micro-organisms. Stroganoff found the bacteria of the vagina extending up to the mucous surface of the cervix, but not penetrating it, and experimentally proved the mucus an unfavorable medium.

Powerful as are the normal defences against bacterial invasion, they may, however, be overthrown under conditions very imperfectly understood. The more important bacteria found in puerperal infections are the streptococcus and staphylococcus, Bacillus coli communis, and Bacillus aërogenes capsulatus (Plate II.).

THE BACTERIAL EXCITANT AND HOST.

Among the micro-organisms gaining entrance into the body there are some which may under suitable conditions induce phenomena by which disease is characterized. These are the ones which induce infectious diseases, and which we habitually refer to as being pathogenic bacteria. The term "pathogenic" is, however, a relative one—a fact which should be held clearly in mind for the reason that an organism quite harmless to one animal may be capable of inducing disease in another, and for the additional reason that an organism which under ordinary conditions is harmless may, under special conditions, give rise to special lesions.

It is evident from what has been said that infectious disease cannot exist without the presence in the body of living micro-organisms. But, on the other hand, the mere entrance of bacteria into the tissues is not sufficient to constitute infection, for it has been seen that many bacteria are harmless, and that the body possesses important safeguards whereby bacteria are destroyed or their effects neutralized. Whether the micro-organisms possess pathogenic activity or not will depend largely upon the host, and also upon their own variable nature and qualities. This relationship of host and bacterial excitant has been stated so admirably by Prudden that one can do no better than quote the following:

"In the study of the infectious diseases it is especially important to bear in mind that the abnormal processes through which the disturbances incited by micro-organisms are manifested are processes of the body cells, and not processes of the micro-organisms. The micro-organisms do, indeed, incite the train of phenomena by which the disease is manifested, and the nature or 'species' of the micro-organism may largely influence the character of the phenomena; but the stored-up energy which is released in this manifestation is body cell energy, and not that of microbic metabolism. The microbes are excitants of disease, but the disease is a performance of the body cells. If these obvious considerations be held in view, it will be convenient in considering certain of the infectious diseases to use the familiar and much-abused term 'specific' as indicative of those phases of abnormal body cell performance which are apt to occur in characteristic ways in response to special forms of microbic stimulus. Thus the poisonous substances which the tubercle bacillus builds up out of the organic material upon which it feeds are in part such as exert a peculiar influence upon connective-tissue cells, leading to their proliferation and the temporary formation of new tissue—the tubercle. This, together with associated action of the same or other metabolic products of the living bacillus, forms a group of lesions and disturbances which is characteristic of the action of the tubercle bacillus in the body. In this sense tuberculosis is a 'specific' disease. On the other hand, the poisons eliminated by the tubercle bacillus may incite responses on the part of the body cells which are practically identical with those which many other toxic substances, both of bacterial and of other origin, induce—fever, degeneration, etc. These manifestations of the action of the tubercle bacillus upon the living body cells are not 'specific.'"

The Bacterial Excitant.—The reaction of the body cells in infection bears a more or less constant relation to the virulence of the infecting micro-organism and to the number of bacteria gaining entrance into the tissues. The virulence varies considerably under different conditions, and according as these variations are small or great, different phenomena will develop within the body. The character of the processes induced will necessarily vary according to the virulence of the infecting bacterium; and this largely depends upon its environment, which may not only modify the morphologic character of the organism, but also may change its physiologic activities. For example, Bacillus coli communis, as found normally in the intestines, is of very low virulence, and is not capable of inciting pathologic processes; but so soon as its physiologic activities are modified by changes in its environment its virulence is apt to be very much increased. This influence of environment is also well shown by the modifications which may occur in the vital activity of an organism when it finds its habitat in new and unnatural hosts. This point is demonstrated especially well with the mammalian tubercle bacillus, which when transmitted for a long time through another animal host, as birds, ultimately loses its virulence for the host from which it originally was derived.

Bacteria which enter the body associated with their toxic products are much better able to induce infection than when they enter deprived of their products. These toxic substances, by damaging at the outset cells and fluids which protect the body from infection, enable the invader to gain a foothold which it otherwise might not have obtained. A similar effect is probably produced by the hypothetical substances called *aggressins* by Bail, which occur in inflammatory exudates.

As a rule, bacteria lose their virulence with greater or less readiness when cultivated in artificial media. On the other hand, successive passages of a pathogenic organism through highly susceptible animals exalt its virulence. Thus a streptococcus of attenuated virulence may be exalted a hundredfold or more by successive inoculation into rabbits.

Differences in the virulence of bacteria often suffice to explain differences in the clinical and morphologic types of disease. It is well known that under some conditions an organism of low virulence will incite rather mild reactions of the body cells; whereas, under other conditions, when the virulence of the same organism is exalted, the effects are more marked both in severity and extent of the lesions.

The number of micro-organisms which gain entrance into the body is also a factor which modifies the character and extent of the cellular reactions. Within certain limitations the healthy body may dispose without apparent injury of a certain number of bacteria of given virulence; but when the same organism is introduced in large quantities infection follows. In highly susceptible animals probably so small a number as one or two anthrax bacilli may incite disease. Usually, however, much larger numbers are necessary for the development of an infection. The question of dosage is largely one of individual and racial susceptibility on the one hand, and of virulence of the micro-organisms on the other hand. The kind of infection produced by some bacteria varies with the dose. Thus it often happens that the introduction of a very small number will produce only a local infection, whereas larger numbers may induce septicæmia. Further, according to the portal of entry, we find variations in the character of the infectious process. Thus, a given dose of bacteria which when injected into the subcutaneous tissues of an animal may prove quite harmless, may induce, when the same dose is introduced intravenously or into the peritoneal cavity, well-marked abnormal cellular reactions.

The study of the influences which other associated organisms may bring into play in the development of infection is an exceedingly interesting one. Mixed infections are common in the human being, especially in suppurating wounds, in which it is usual to find more than one bacterial species. Sometimes the association of one species may be without influence upon the properties of another, or it may enhance or lower the virulence of one or the other. Bacteria exert their influences on each other largely through their chemical products, and it is often possible to bring about modifications of character by exposing one species to the action of the chemical products of another. Such a process is exemplified by the action of the bacillus lactis on the bacteria of intestinal putrefaction—use of which is made in the treatment of intestinal auto-intoxication. Sometimes concurrent inoculation of two different bacterial species inhibits the influence of one or both. Thus, simultaneous inoculation of Bacillus pyocyaneus and Bacillus anthracis into a susceptible animal is often without pathogenic effect. More often, however, the concurrent inoculation of two species rather increases the danger from one or both, although sometimes a bacterium of attenuated virulence may become augmented in virulence by the inoculation of another species which need not necessarily be pathogenic itself. Thus the pathogenic effects of the tetanus bacillus are much enhanced when it is associated with pyogenic bacteria. It sometimes happens that infection with one species paves the way for infection with another.

The Host.—It is, of course, well known that certain bacteria will induce infections only in separate species of animals, proving absolutely innocuous for other species. Thus, while the anthrax bacillus usually induces lesions with the greatest readiness in many animals, others, like the white rat, are ordinarily insusceptible to inoculation with these bacilli unless very large amounts be given or special factors be brought into play. Furthermore, some diseases are especially peculiar to man, such as typhoid fever, leprosy, scarlet fever, measles, etc., these diseases never occurring naturally in other animals.

Racial predisposition may be inherited or acquired, or general or local. Negroes are generally insusceptible to yellow fever, whereas other human beings are quite susceptible to the pathogenic agents of this disease.

The influence of age is so well known that investigators commonly make use of this knowledge in their experimental work. As a predisposing factor to infection this is well illustrated by the curve of frequency of infectious diseases in man, the maximum point occurring in children. Numerous other conditions affecting the normal physiologic integrity of the body also favor the development of infectious disease. For example, the influence of fatigue, starvation, cold and heat, and loss of blood has been studied particularly from an experimental point of view, the results conclusively proving that a marked susceptibility to infection is developed when any of these factors is brought into play.

Any traumatic injury to the body tissues also favors the lodgment and activity of whatever bacteria may reach the affected area. This is illustrated by the well-known clinical fact that tuberculosis of bones and joints of children often follows different forms of trauma.

Other factors have also been investigated, such as the action of chemical substance and unsuitable diet, the latter especially by Hankin, who fed refractory rats on sour milk and bread. Such treatment made the animals extremely susceptible to anthrax infection.

The local predisposition may be limited to one or more of the portals of entry, or it may exist at some point within the body, constituting a so-called locus minoris resistentiæ. The character of the tissue infected, the presence of local anæmia or passive hyperæmia, the withdrawal of nerve-impulses from a point, the rapidity of absorption, the presence of foreign bodies, are also modifying factors in the susceptibility to infection. Wounds through poorly vascularized tissues generally offer but slight resistance to bacterial invasion. The presence of œdema in the tissue likewise favors infection.

Contrary to the general belief, suppurating surfaces offer considerable resistance to the entrance of bacteria into the body, for pus possesses distinct bactericidal power, partly from the cells and partly from the fluid portion. Thus the danger of bacterial absorption from suppurating surfaces is much less than from fresh wounds. The existence of suppuration, however, lowers the general resistance of the individual.

Among the local conditions favoring the growth, in wounds, of bacteria which might otherwise be disposed of by the tissues or animal fluids, may be mentioned strangulation of masses of tissue by ligature, the presence of foreign bodies, interference with the circulation from undue pressure and tension.

ACTION OF BACTERIA AND THEIR PRODUCTS IN THE BODY.

Micro-organisms induce their effects in several ways, but chiefly by their presence in the tissues, and by the development of their poisonous products, which either affect the physiologic activity of the cell or kill the cell outright. These poisonous products act in varying degree, generally or locally, according to the nature and quantity of the product formed. Such toxic substances become diffused through the system, and the clinical manifestation of their effects is shown by the occurrence of fever, disturbances in the functions of the respiratory and nervous systems. In some cases changes are found locally in the tissues directly involved. The general effects of bacterial poisons may be so slight as to be regarded as of little importance, as in the case of a local inflammation; or they may be very intense, as in tetanus and diphtheria. In diseases like tetanus and diphtheria it is usually only in the local lesion that the bacilli are found; and the profound systemic intoxication is due to absorption of the highly toxic products from the local lesion.

Whenever there is a widespread distribution of pathogenic bacteria in the blood the condition is designated septicæmia; and if associated with multiple foci of pus-formation, the term pyæmia is applied. The body, which is already the seat of infectious disease, is much more susceptible to invasion by other bacteria; thus, mixed or concurrent infections are often present. Individuals the victims of long-standing chronic diseases, such as those of the heart, lungs, kidneys, and liver, often succumb to infectious diseases of one kind or another. The term *terminal infection* has been applied by Osler to these infectious diseases.

IMMUNITY.

Immunity is characterized by resistance to infection or its effects. The absence or loss of this capacity is known as susceptibility. Immunity from an infectious disease may be hereditary or it may be acquired, either by an attack of the disease from which the individual has recovered—natural immunization—or by the introduction into the body of something which diminishes susceptibility—artificial immunization. Acquired immunity may be transmitted from parent to offspring.

Many of the infectious diseases confer greater or lesser immunity to subsequent attacks of the same disease, although there are exceptions to this rule. A previous attack of erysipelas renders one more susceptible to subsequent infection with the streptococcus.

From the study of infection it is known that two distinct influences are evidently at play in enabling the body to resist infection. It has clearly been shown that the destruction of bacteria may in part be brought about by the leucocytes and other mesodermal cells, which when thus engaged are called phagocytes. In the body fluids there are also certain albuminous ingredients which have well-marked bactericidal properties.

A number of theories have been advanced to explain the essential nature of immunity. They may be grouped into two classes: The *humoral*, which attributes immunity to extracellular fluids of the body, and the *cellular*, which assumes that the direct action of the body cells is most important.

The *humoral* products of immunity which are best known are antitoxins, lysins, opsonins, precipitins, and agglutinins.

Antitoxins result after the introduction into the body of toxins under suitable conditions, and are protective and curative because they unite with toxin of the kind which has called it forth and prevent it from causing disease by union of the body cells with toxin.

Lysins result from the introduction into the body of bacteria and other cellular bodies, under suitable conditions, and act by dissolving or destroying the cellular bodies of the type which called forth their production.

Opsonins are substances in the serum which result after the introduction into the body of bacteria and some other cellular bodies under suitable conditions, and act by forming a union with these cellular bodies in such a way that they may be more readily engulfed by phagocytic leucocytes.

Precipitins are substances in the blood-serum which result from the injection into the body of various protein substances of animal, vegetable, or bacterial nature having the power of forming a precipitate when mingled with these substances. This action is more or less specific for the especial form of substance.

The same is true of agglutinins, which under similar circumstances are capable of drawing together into clumps bacteria and other cellular bodies which have been introduced into the serum of animals.

While precipitins and agglutinins are thought, undoubtedly, to have a place in the protective mechanism of the body, their true rôle is not yet known.

As methods of determing the type of infection which the body is undergoing, however, these phenomena—on account of their specific action—are great diagnostic aids. The one best known at the present time is the agglutination of typhoid bacilli in the presence of the serum of typhoid fever patients, known as the Widal reaction.

As a result of these phenomena the following various serotherapeutic measures have been inaugurated to overcome the deleterious effects of bacterial infection.

Curative injections by (*a*) active immunization and (*b*) passive immunization.

(*a*) Active immunity is secured through the action in the body of bacteria whose virulence has been reduced but not rendered altogether inert. Common examples are bacterial suspensions, recently designated as vaccines, of staphylococci, streptococci, gonococci, colon bacilli, and other organisms.

The use of these substances has been encouraged through the researches of Wright, who recommends the use of the opsonic index to regulate the size and intervals of their dosage.

Bacterial vaccines are prepared from cultures of the organisms causing the infection, grown on agar. A suspension is made of the bacteria in normal salt solution, and this is then standardized by determining the number of bacteria per cubic centimeter of fluid. After sterilization by exposure to a temperature of from 65° to 75° C. for half an hour and the addition of 0.5 per cent. lysol, this material is ready for inoculation.

Tuberculin—especially Koch's new tuberculin, known as tuberculin R—is a substance belonging to this class of immunizing agents. Up to the present time this form of immunization has been most successful in cases of localized infection.

(*b*) Passive immunity is secured by the direct mingling of the body fluids from an individual already immunized with those of the individual to be protected. Such fluids are the antitoxic sera—represented by diphtheria and tetanus antitoxin and others—and antibacterial sera, to which group belong the sera of typhoid, cholera, plague, dysentery, etc.

These methods may be applied not only for curative purposes but also to prevent the effects of future infections. Protective passive immunization may thus be obtained for comparatively short periods of time by the use of diphtheria and tetanus antitoxins where infection by the corresponding organism is threatened.

Of the agencies producing protective active immunization, the most familiar are the vaccine of Jenner, producing immunity to smallpox, and the antirabies vaccine of Pasteur. In both of these cases, as well as in some successful experiments in tuberculosis immunity, immunization is secured through the injection of living attenuated organisms. The use of dead organisms as vaccines for the production of active immunity has recently met with a certain degree of success in protection against infection of typhoid fever, plague, and some of the pyogenic organisms. The protection afforded by active immunization is generally of longer duration than that afforded by passive immunization.

It is to Metchnikoff and his pupils that we owe most of the facts upon which the cellular theories of immunity are based. Immunity, it is asserted by those who take this view of immunity, is dependent upon the activity of living cells, the germicidal action of the body fluids being due to secretions from the leucocytes and other cells. (See Phagocytosis, under Inflammation.) It is probable that the body fluids and body cells both play an important rôle in the development of immunity.

CHAPTER II.

INFLAMMATION.

Introduction.—With a fuller appreciation of the structure and physiologic traits of cells, chiefly based on studies in biology and comparative pathology, the original significance given to the processes of inflammation has been much changed within recent years. Originally the conception of inflammation was a comparative simple one, based chiefly on certain clinical manifestations—redness, heat, swelling, pain, and impaired function; but now it is regarded as a far more complex local process, in which circulatory disturbances and retrogressive and progressive changes are associated in varying degrees. These changes are induced by some form of injury. While the external manifestations of the process may vary considerably, it has been shown that in each case the fundamental changes are essentially the same whatever the exciting cause. Thus inflammation has been defined as "the local attempt at the repair of injury" (Adami).

INFLAMMATION.

Cause.—Although the varieties of inflammation are dependent upon the character of the cause and the nature of the reaction, they may be grouped, according to their intensity and duration, into the *acute* and *chronic* forms.

In either form the active or exciting cause may have been direct violence, producing physical irritation, a chemical irritant, or micro-organisms.

While any one of these agencies may, in itself, be sufficient to incite inflammation, in some instances they are only able to produce this result through the operation of some *predisposing* cause. Such, for example, are deficient quantity of blood, as in Bright's disease, diabetes, chronic alcoholism, gout, and syphilis; interference with normal nerve influence ; old age ; or debility.

Acute Inflammation.

Symptoms.—**Local.**—The cardinal signs of inflammation have long been recognized as heat, redness, swelling, and pain, and to these may be added interference with function in the inflamed part and general constitutional disturbance. While inflammation may exist in the absence of some of these signs, and while some of them may be present in the absence of inflammation, the coexistence of all, or even of a majority of them, is usually sufficient to establish the diagnosis of inflammation. The *redness* is due to arterial and especially to venous and capillary hyperæmia; the *swelling*, on the other hand, is partly due to hyperæmia, serous exudation, and leucocytic emigration. The *pain* is due to stretching of or pressure upon nerves by exudates, and also to direct changes in the nerve-filaments. Although the *temperature* of the involved part may be elevated beyond the normal, it never exceeds that of the interior of the body. *Disturbances* or *loss* of function depend on the structural and physiologic alterations which occur in the tissue affected.

General Symptoms.—These may be absent in inflammations of a limited and moderate nature; but when the inflammation is extensive and severe, fever is ordinarily present. It is induced by the absorption of poisonous substances from the local area of inflammation. There is usually leucocytosis, polymorphonuclear in type.

Clinically, all cases with fever are attended with certain symptoms in common, due partly to increased tissue changes, partly to increased heat of the body, and in part to functional disturbances of certain organs. There may be malaise, sleeplessness, thirst, loss of appetite, mental disturbance, increased frequency of pulse and respiration, lessened amount of urine, etc. If the absorption of toxins is excessive, or a vital organ is involved, death may result, or all symptoms may subside and the process may terminate in resolution, or may continue as a chronic condition.

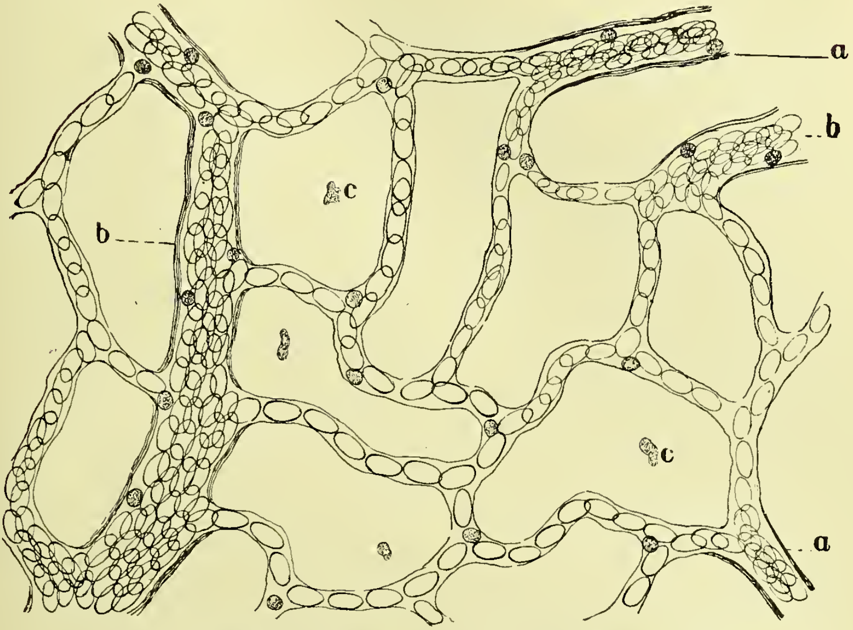
In acute inflammation the character of the minute tissue changes depends upon the vascularity or non-vascularity of the tissues. In non-vascular tissue the process of inflammation, if mild, is a comparatively simple one, consisting merely of necrosis, followed by proliferation of the fixed cells. In more intense inflammations leucocytes travel along the lymph-channels from the congested vessels at the periphery to the focus of inflammation. The force thus attracting the leucocytes, known as *chemotaxis*, is exerted through the presence of pathogenic bacteria or their products, and many of the early products of tissue disintegration. While the leucocytes are attracted by the majority of pathogenic bacteria, they are repelled or destroyed by a few that are especially virulent.

Many of the leucocytes may take up micro-organisms, and by the action of intracellular ferments bring about more or less complete digestion of the ingested bacteria. This phenomenon is known as *phagocytosis*. While usually resulting in the destruction of the ingested bacteria, these are not always killed; on the contrary, under some circumstances the ingested bacteria and their products may destroy the phagocytes.

The digestive action of leucocytes on bacteria may not be confined to bacteria within their bodies, for after their disintegration ferments may be released and imparted to the exudate or serum which have a bactericidal action. To such substances the term *alexins* has been applied.

In vascular tissue the inflammatory reaction is much more complex than in non-vascular tissue, with many gradations from mild to intense. In the earliest stages of inflammation there is arterial dilatation, and at the same time an increase in the rapidity of flow of blood, which is of short duration. This is followed by a dilatation of the veins and capillaries, with a slowing of the blood current. The leucocytes now have a decided tendency to accumulate in the outer portion of the veins and capillaries, and to adhere to the vessel walls. This is followed by *emigration* of the leucocytes through the vessel walls. The slowing of the blood current is progressive, and in some vessels complete stasis occurs. Red cells may escape into the tissues either by diapedesis or

FIG. 1.

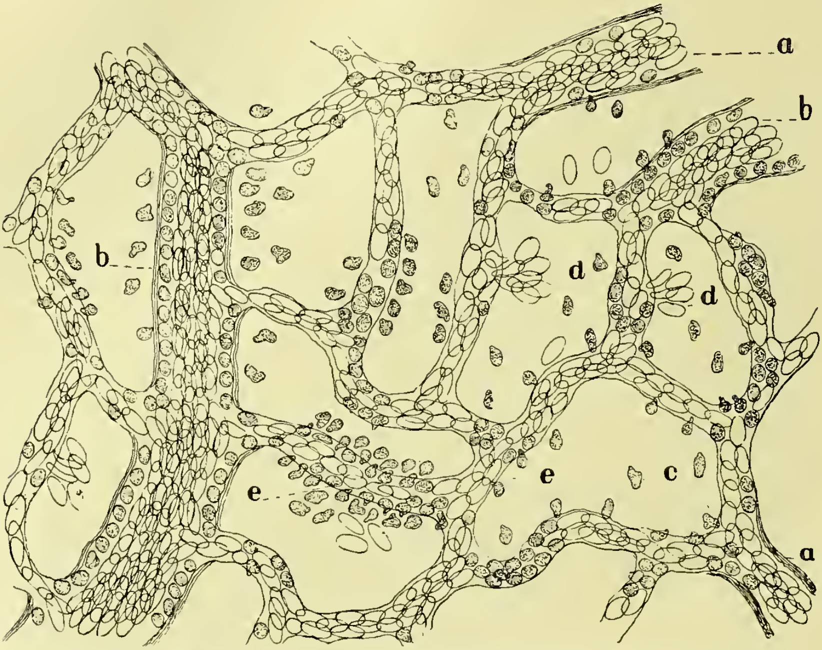


Portion of the mesentery of a frog, showing normal circulation: *a*, *a*, small arteries just breaking up into capillaries; *b*, *b*, small veins; *c*, *c*, wandering cells (leucocytes in connective tissue). (Dennis.)

rhexis. Plasma also escapes, which, becoming mixed with disintegrating leucocytes, may give rise to fibrin formation. (Figs. 1, 2, 3, and 4.)

If now the cause of the inflammation ceases to act, and the vitality of the tissues has not been too much lowered to permit of their recovery, the stasis ceases, the emigration of leucocytes discontinues, and those that have already escaped wander back into the bloodvessels, or lymphatics, or break down—the dead cells being dissolved by cellular ferments—and the part is left apparently uninjured. This is called *resolution*.

Fig. 2.

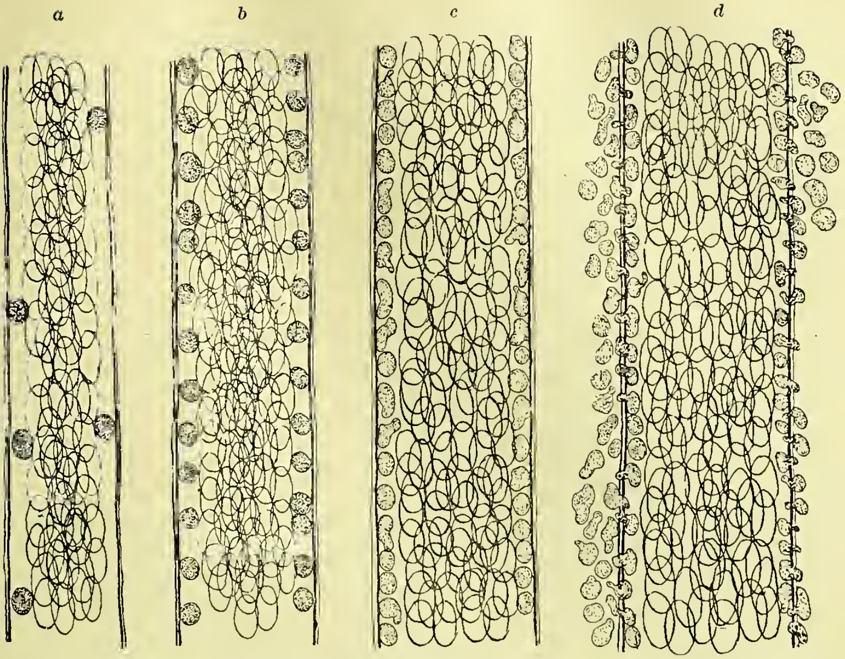


The same vascular territory as shown in Fig. 1, two hours after exposure. All of the vessels are dilated. The leucocytes are more numerous; they have collected along the walls of the vessels, and in several places are passing through; at *d* diapedesis of the red corpuscles is shown, and at *e* emigration of leucocytes. There are large numbers of leucocytes in the connective tissue. (Dennis.)

If the cause of the inflammation continues and is mild, the process may become a simple chronic inflammation, or, if more severe, may result in suppuration, which, in turn, may become chronic.

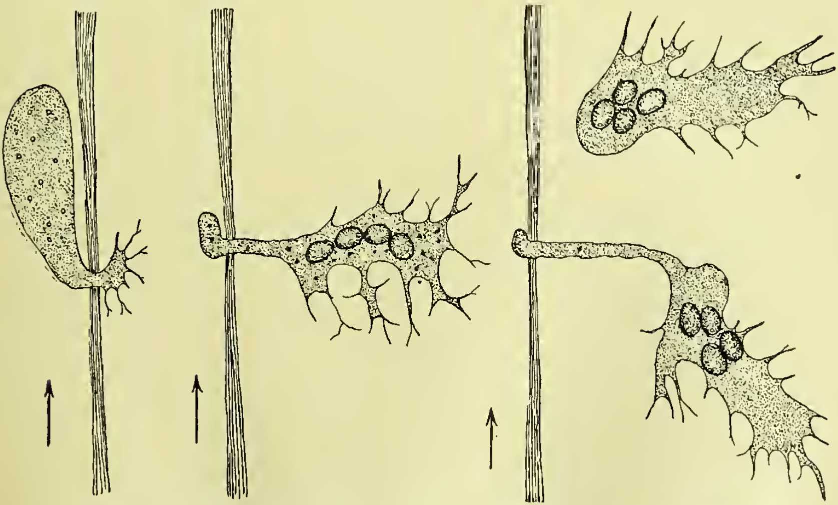
If the suppurative process occurs in the substances of the tissues it is known as *cellulitis* if diffuse, and as an *abscess* if circumscribed. If it occurs on a free surface it is known as a *purulent exudation*

FIG. 3.



Diagrammatic view of inflammatory changes in a small vein: *a*, normal circulation, showing plasma-zone; *b*, *c*, *d*, successive changes, showing dilatation, accumulation of leucocytes, and emigration. (Dennis.)

FIG. 4.



The process of emigration, observed under high power. The blood is supposed to flow on the left of the line in the direction indicated by the arrow. The tissue is on the right. × 1000. (After Thoma.) (Dennis.)

if the superficial layers of epithelium are involved, or as an *ulcer* if the process extends through to the deeper parts with necrosis of the epithelium.

The tissue damage by a suppurative process may be replaced by thickened or indurated tissue, giving rise to a connective-tissue fibrosis—often resulting in *cicatrization*—or all the tissues in the inflamed area may lose their vitality and die "en masse" (*gangrene*).

Chronic Inflammation.

While chronic inflammation may be the immediate result of the specific infectious agencies of such diseases as tuberculosis and syphilis, it may result secondarily to an acute process from other causes, where the subsidence of the process is slow and gradual.

The causes of chronic inflammation are similar in kind to those of the acute processes, but act with less intensity and for longer periods of time. The local symptoms—redness, pain, and heat—may be very slight or entirely absent. Swelling is frequently a marked sign.

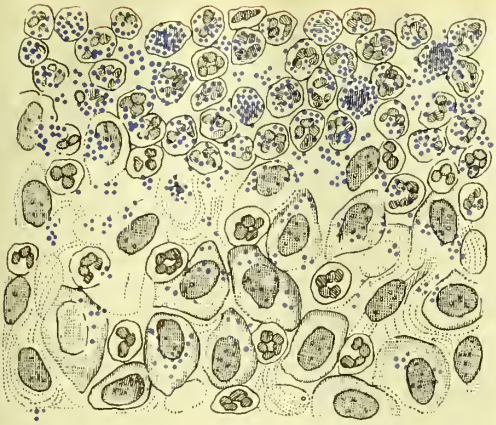
Constitutional symptoms are generally absent, except for evidences of general debility, gouty, rheumatic, or syphilitic symptoms.

The minute tissue changes in the early stages resemble those of the acute form, with greater sluggishness of the blood supply and proliferation of the fixed tissue elements. This may result in the collection in the adjacent tissue of numerous small round connective-tissue cells which later are converted into dense fibrous tissue, giving to the part the firm elastic character evident on clinical examination. In other cases, as in syphilis, actinomycosis, or tuberculosis, the local irritation produced by the specific organism gives rise to circumscribed areas of round-cell infiltration, which have a strong tendency toward necrosis, caseation, or calcification. These lesions are spoken of as the *infective granulomata*. Like acute inflammation, the chronic may terminate in resolution, suppuration, or ulceration; but the fibrous and necrotic changes just described are the terminal results most frequently seen.

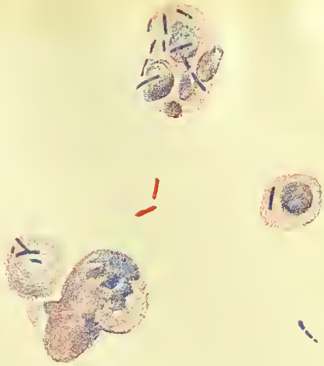
SUPPURATION.

Suppuration is produced by the action of certain organisms known as the pyogenic bacteria on the tissues of the body. While some of these, as the staphylococci, streptococci; the pneumococcus, gonococcus, bacillus coli communis and bacillus pyocyaneus always produce pus as a result of infection by them, others are capable of producing pus only at times.

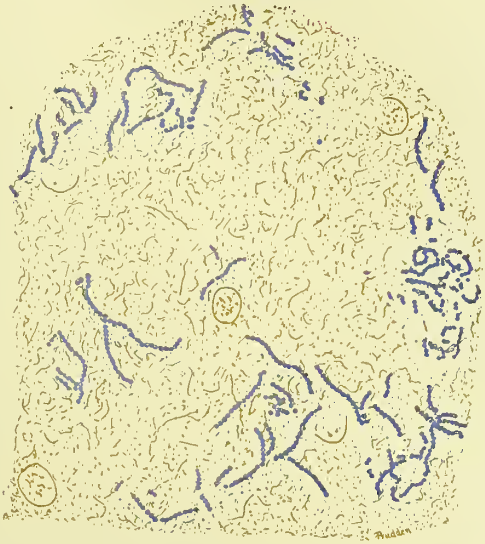
PLATE II



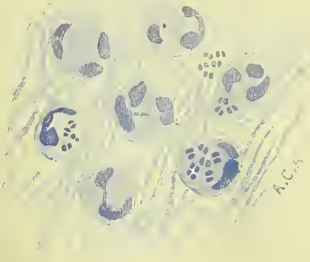
Section through wall of abscess, showing staphylococcus pyogenes aureus. (Baumgarten.)



Coverglass preparation of pericardial exudate, showing bacillus pyocyaneus stained blue and the tubercle bacillus stained red. (Ernst.)



Streptococcus pyogenes. Streptococcus erysipelatos. (Prudden.)



Micrococcus gonorrhœæ or gonococcus. (Abbott.)

Micrococcus lanceolatus (Abbott.)

Some Forms of Bacteria Giving Rise to Surgical Infections.

To this group belong the typhoid, proteus, diphtheria, tetanus, tubercle, anthrax, and glanders bacilli, and the bacillus of malignant œdema.

Pus, caused by these organisms as a class, is a yellowish creamy substance with a faint odor, having an alkaline reaction and a specific gravity of about 1030. It is composed of a solid and a liquid part; the former consisting of leucocytes, some of which may still retain amœboid movements, most of which, however, are undergoing degeneration and disintegration. In addition to these may be found dead tissue cells, red blood-corpuscles, fibrin, micro-organisms, etc. The liquid part resembles modified plasma, which does not clot on standing, but which may be coagulated on boiling.

Certain variations in the appearance of pus are dependent upon the character of the organisms calling it forth.

For example, while the pus in staphylococcus infection is dirty white, moderately thick, with a somewhat sour odor, that of the bacillus coli communis is thick, brownish, with fetid odor; or thin, dirty white, with thicker masses.

Pus from streptococcus infection is usually thin, white, occasionally blood-tinged, with shreds of tissue, while that from the bacillus pyocyaneus is distinctly green or blue in color.

Pneumococcus pus is usually thin, watery, and greenish, while tubercle bacillus pus is usually thick, curdy, paste-like, or thin and greenish, containing cheesy lumps.

A suppurative process may occur in a circumscribed area, forming a local abscess, or it may infiltrate the tissues, forming a diffuse cellulitis.

Acute Abscess.—The minute tissue changes, occurring in the early stages of abscess formation, have already been described under *inflammation.* If the inciting organism remains active, the exuded leucocytes gather about the focus in large numbers, with the other products of inflammation, and as a result of the action of the bacterial toxins, these cells, as well as endothelial and connective-tissue cells, undergo necrosis. Through the action of cellular and bacterial ferments this necrosed exudate becomes liquefied, resulting in a focus of pus or abscess.

About this central focus is an inflammatory zone of tissue, infiltrated by leucocytes and other products of inflammation, in which the capillaries are dilated.

As the process extends the central area of necrosis becomes larger, and as the pressure at this point is considerable, the process advances along the line of least resistance until it points upon a free surface or in some body cavity. In the course of this advance the pus may burrow for some distance between fascial planes. Such a course makes operative relief by incision and drainage more difficult.

After the evacuation of pus, bacteria, and toxines from an abscess cavity, healing may occur by granulation. This consists in the formation of new tissue, containing newly formed capillaries growing inward from the abscess wall, eventually filling up the cavity with connective tissue, which later becomes fibrous, dense, and covered with epithelium.

In the absence of repair, at any stage the infection may travel along the lympathic ducts supplying the part, to the nearest lymph-node, which becomes inflamed and enlarged. The process may stop in the first or second of a chain of nodes, or the infection may pass into the blood, resulting in a septicæmia or pyæmia, which may prove fatal. These conditions will be described subsequently.

Chronic Abscess.—This form of abscess may result from long duration of an abscess, originally acute, the exciting cause of which is an enfeebled pyogenic organism, or one of slight virulence. More frequently, however, a chronic abscess is of slow formation from the start, and due to infection by the inciting organism of tuberculosis, syphilis, actinomycosis, or blastomycosis.

The pus from a simple chronic abscess may be thin and curdy, may contain shreds of necrotic tissue, but often differs little from ordinary pus.

Locally, a fluctuating swelling is the chief sign, often unattended with any sign of inflammation. Constitutional symptoms are rare.

The minute tissue changes of a chronic abscess differ from those of the acute type, chiefly in regard to the amount of new formed connective tissue in the wall of the abscess, with increased density of the tissues.

As a result, this dense wall may closely simulate a capsule, which is impervious to the flow of fluids through it. In this way the ready access of blood-serum from the general circulation, with its contents of bactericidal and antitoxic substances, to the active focus is prevented.

The symptoms and treatment of chronic abscess will be considered in subsequent chapters.

Sinus.—A sinus is a persistent tract which remains after an abscess in the tissues has discharged upon the surface of the skin, or of a mucous membrane.

The cause is usually the presence of a foreign body in the original focus, or an insufficient outlet of pus from an abscess.

Fistula.—Although occasionally the result of a wound, ulceration, sloughing, or of a congenital defect, a fistula is usually due to the non-closure of an abscess, and differs from a sinus merely in being open at both ends. It may connect some hollow viscus or the duct of a secreting gland with the surface of the body. The fistulæ most commonly seen occur in connection with the gastro-intestinal tract, the urethra, or bladder.

For their treatment more or less complicated plastic operations are usually necessary, which will be subsequently described.

CHAPTER III.

ACUTE INFECTIOUS SURGICAL DISEASES.

Acute General Sepsis.

Septicæmia, Pyæmia, and Septic Intoxication.—Although formerly considered separate diseases, these three conditions are best regarded simply as different types of acute general sepsis. Whenever pathogenic bacteria gain access to, and grow in the systemic circulation and tissues, the condition is referred to as *septicæmia.* If, on the other hand, such generalized infection be associated with the development of remote foci of suppuration, it is designated *pyæmia.* It has been customary, especially among surgeons, to limit these terms to infections with the pyogenic micro-organisms, but such limitation is incorrect. The term *septic intoxication* is used to indicate a condition due to the absorption of toxins, mainly of bacterial origin. *Sapræmia* is a term sometimes employed to signify a form of intoxication due to absorption of the poisons of putrefactive micro-organisms. It is not always possible to distinguish sharply between infections and intoxications; indeed, the manifestations of infectious disease are nearly always referable to bacterial poisons.

Some infections are purely local, as tetanus and diphtheria, the most important lesions and symptoms being due to absorption of toxic substances from the seat of inoculation. The so-called intoxications exhibit themselves by febrile manifestations, nervous, cardiac, and respiratory disturbances, and other symptoms. Very often the toxic material is absorbed from the intestine.

The septicæmias generally may be traced to the entrance of the bacteria at some definite portal; but sometimes it is impossible to determine the point of entrance—*cryptogenetic* infections. Many of the organisms gain access to the blood through the skin or mucous membranes of the alimentary, respiratory, and genito-urinary tracts. Such infections may follow recent or old injuries; or they may come on in the course of various diseases, such as pneumonia, erysipelas, typhoid fever, puerperal fever, etc.

The organisms most frequently etiologically related to the development of surgical septicæmias are Streptococcus pyogenes, Staphylococcus pyogenes aureus, Pneumococcus, Bacillus coli communis, Gonococcus, Bacillus pyocyaneus, Bacillus aërogenes capsulatus, and Bacillus anthracis. More than one bacterial species may be present in the blood. The bacteria concerned in pyæmia are essentially the same as those found in septicæmia. Why they should in one instance induce foci of suppuration and not in another, it is not always possible to state. Pyæmia is much less frequently seen now than formerly. In most cases there is some primary focus of infection, either an osteomyelitis, an otitis media, an external suppurating wound, a gonorrhœa, or other lesion containing pathogenic bacteria. Metastatic abscesses usually are formed by fragments of infected thrombi which are carried into the circulation, and eventually are arrested in small vessels and thus form embolic foci of suppuration. The abscesses are generally found in one or more of the viscera: as the kidneys, lungs, liver, spleen, or heart. When the focus of infection is within the areas supplied by the portal vein, pylephlebitis often develops, with multiple abscesses in the liver.

At autopsy the spleen is found swollen and soft, and on the serous surfaces minute hemorrhages are frequent. The lungs may be congested and the other viscera show parenchymatous degeneration. Embolism and thrombosis with infarction are not uncommon.

Symptoms.—In all cases of acute general sepsis there are fever, prostration, and rapid wasting. In the *intoxications* due to an accessible septic focus there is often a chill, followed by high fever, rapid heart action, headache, general malaise, and often restlessness and delirium. Accompanying these there is pain at the seat of infection, with swelling, redness, and other evidences of inflammation. If the septic focus is promptly opened and disinfected, the symptoms rapidly subside. In the *septicæmic* type of general sepsis the symptoms are at first similar to those of simple septic intoxication, but are not relieved by the opening and disinfection of the primary focus. On the contrary, there is continued high fever, with great prostration and progressive loss of flesh and strength. Nausea and vomiting, diarrhœa, albuminuria, and symptoms of uræmia may appear. Delirium is marked and coma may develop shortly before death. In the *pyæmic* type of the disease the onset is, as a rule, more gradual; and if preceded by symptoms of intoxication from an unrelieved septic focus the first sign of the pyæmic process may be the occurrence of a metastatic focus in some remote portion of the body. In the majority of instances, however, there are chills, irregular fever with marked daily remissions and profuse sweats. The skin becomes sallow, and evidences of metastatic abscesses develop in the lungs, liver, brain, kidneys, joints, and on the surface of the body. In all three types of the disease leucocytosis is present, and in the two last ulcerative endocarditis is apt to develop. In these cases petechial hemorrhages are occasionally present.

Prognosis.—In simple intoxications the prognosis is generally favorable if the focus can be found and removed. In the septicæmic and pyæmic types the prognosis is decidedly unfavorable; the former generally die in from ten to fourteen days; the latter, in from one to four weeks.

Treatment.—The treatment of general sepsis consists in measures to remove the focus of infection, destroy the circulating bacteria, neutralize their toxic products, hasten the elimination of the poison, and to increase the natural resistance of the patient. Local measures consist in opening and evacuating the focus of infection, the employment of drainage and antiseptics. Removal of an infected bone or organ or amputation of an extremity may be necessary. To hasten the elimination of the poison are employed calomel, saline purgatives, the ingestion of large quantities of water and fluid food, and the use of copious rectal irrigations, hypodermoclysis, and intravenous infusions of normal salt solutions. To uphold the system generally are employed stimulants and an abundance of nourishing food and fresh air.

The antiseptic most generally employed to combat the blood infection is Crede's preparation of colloidal silver, known as collargol. This is employed as an intravenous injection of 2 to 10 c.c. of a 2 per cent. solution, or 500 to 1000 c.c. of a $\frac{1}{10}$ per cent. solution. This is a non-irritating, strongly bactericidal agent, which in some cases has been used with great benefit. Of the bacteriolytic sera, few have given promise of yielding favorable results. The antigonococcic serum of Torrey Rogers and Beebe has produced benefit in infections by this organism, which has been most evident in the local manifestations—as arthritis. Antistreptococcus serum has been employed for some time with reports of a few favorable results. As the number of varieties in each of these bacterial groups is probably large, a polyvalent serum should be employed. Failure in the past to derive beneficial results from the use of this serum in all probability arises from the fact that there is a scarcity of *complement* available at the time of injection to actuate the serum employed. This may be overcome by deriving the therapeutic sera from a species of animal closely allied to man or by increasing the amount of complement in the blood of the patient. Abbott, Longcope, and others have already shown that the amount of complement in the blood may be reduced by alcohol and various chronic as well as acute diseases. The use of bacterial vaccines, while productive of beneficial results in some local infections, have given little promise of help in systemic infections.

Recently Hiss has reported beneficial results in staphylococcus, streptococcus, pneumococcus, and meningococcus infections from the subcutaneous injection of extracts of leucocytes. The action of these extracts is believed to be due to endo-antitoxins liberated from the disintegrated leucocytes. It is possible that the amount of *complement* is also thus increased.

Erysipelas.

Erysipelas is an acute infectious disease, characterized by a spreading inflammation of the skin, induced by Streptococcus pyogenes. There is a tendency to spontaneous recovery. The disease is accompanied by febrile disturbances.

Etiology.—The inciting bacterial agent is a streptococcus, as was shown by Fehleisen, in 1884. He obtained pure culture of the organism and named it Streptococcus erysipelas. It is now generally assumed that this organism and Streptococcus pyogenes are the same.

Erysipelas is endemic in most countries, and is particularly frequent in the spring. Formerly, and to a less degree at present, it prevailed extensively in old hospitals in which the sanitary conditions were bad. Chronic alcoholism, chronic nephritis, and other diseases are predisposing factors. The most frequent point of entrance for the streptococcus is through a wound of any sort. It is often impossible, however, to find the point of entrance. The disease is sometimes considered contagious. The relation of erysipelas and puerperal fever was first called attention to by O. W. Holmes. In the new-born—*erysipelas neonatorum*—infection of the cord-stump was formerly very frequent.

Morbid Anatomy.—The lesion is characterized by a simple inflammation of the skin, with considerable exudation of fluid. The streptococci are present in large numbers in the lymphatics of the skin and underlying tissues, especially in the zone of spreading inflammation. They are also present in the adjacent non-inflamed parts. As the inflammatory process advances the cocci gradually die, and further extension at the periphery ceases. In severe cases there may be suppuration. The streptococci may invade the various organs of the body, thus inducing septic complications.

Symptoms.—The incubation period is from three to seven days. Constitutional symptoms are usually manifest before the local symptoms. There is often a rigor, followed by an elevation in temperature. Some enlargement of the lymph-nodes may, perhaps, be detected in the region of the wound, if any exists. Soon there is a feeling of increased tension in the wound, which is hot, tender, and red. With the appearance of exudation the skin becomes red, smooth, tense, and œdematous. Vesicles or blebs may appear. The swelling extends and the local redness shows a tendency to spread. If present on the extremities, the inflammatory process travels toward the trunk; and if on the face (where it generally starts from the bridge of the nose), it progresses toward the scalp. The line of demarcation is sharp. In wandering erysipelas the process may involve large areas. In the facial form the swelling may be enormous, so that the eyes are closed, the nose of grotesque proportions, and the lips much thickened. Moderate fever persists. The leucocyte count is from 10,000 to 20,000. Delirium may be present. The constitutional symptoms are due largely to absorption of toxic products. At the end of four or five days the temperature falls. Erysipelas may reappear in the affected part or elsewhere. This tendency to recurrence is characteristic of the disease. At the end of ten days or two weeks recovery is usually complete. Some patients suffer from recurring attacks at certain times of the year on particular parts of the body. Among the complications may be mentioned spreading cellulitis, sloughing (phlegmonous erysipelas), which may be extensive, septicæmia, endocarditis, pneumonia, meningitis, and nephritis.

Prognosis.—The prognosis is generally good. The hospital mortality is about 7 per cent., but in private practice the death-rate is much lower.

Treatment.—Isolation is regarded by some as important, although there is little evidence to prove that the disease is ever transmitted by air infection. Transmission of the disease by contact is, however, of frequent occurrence, and those in attendance upon a case should not perform surgical operations or attend cases of confinement. Drugs are not needed, except in the old and feeble, to whom stimulants may be given. Large doses of the tincture of chloride of iron, sometimes with quinine, have been recommended, but their value is doubtful. The injection of antiseptics at the margin of the spreading areas has been greatly lauded by some. The local application of ichthyol, of weak solutions of carbolic acid or aluminium acetate is frequently serviceable. It is important to remember that the disease is self-limited, and generally runs its course despite any treatment. Recently, beneficial results are reported to have attended the use of antistreptococcus serum in this condition.

Erysipeloid.

This is a form of dermatitis occurring usually on the finger or hand from inoculation by decomposing animal matter, and most frequently seen in cooks, butchers, and fish dealers. Rosenbach attributes the disease to an organism of the cladothrix group. The heat, swelling, pain, and redness are marked—the latter occurring at first as a line of demarcation, which may slowly spread over the entire hand. Involvement of the lymphatic ducts and glands may occur, but systemic symptoms do not follow. The treatment consists in the local application of a plaster of salicylic acid (25 per cent.) for three days, followed by a simple ointment.

Tetanus (Lockjaw).

Tetanus is an infectious disease usually following traumatic injuries, and is characterized by tonic spasms of the muscles, beginning with those of the jaw and neck, and progressively affecting the muscles of the trunk and extremities. The disease is incited by the tetanus bacillus.

Etiology.—The general association of the disease with the presence of wounds suggested its infectious nature a long time ago. Carle and Rattone in 1884 announced that they had induced the disease in rabbits by inoculations with material from a wound in an individual suffering from tetanus. The following year Nicolaier established the fact that inoculations of animals with earth from various sources often were followed by the development of tetanus. He described the tetanus bacillus, but was unable to isolate it in pure culture; this was done subsequently by Kitasato in 1889. The tetanus bacillus is a small, slender rod, usually associated with other organisms when observed in the pus from wounds. In cultures it appears as a bacillus from 4 to 4.5 μ in length and 0.4 μ in thickness. It stains readily with the usual stains and also by Gram's method. It is slightly motile and possesses flagella. It readily forms spores, and then presents the very characteristic "drumstick" appearance. The natural habitat of the organism has been shown to be the earth. It is found especially in garden soil and in the contents of dung heaps, where it probably exists as a saprophyte. By the employment of appropriate methods for the growth of anaërobic bacteria it may be cultivated artifically. It is a strict anaërobe, and sporulation may begin at the end of twenty-four hours. The spores are very resistant, and may withstand boiling for five minutes; they may also be kept alive in a dry condition for many months without losing their virulence. Their resistance to antiseptics is considerable. The disease may be induced experimentally in animals by the usual methods of inoculation. The organisms remain confined to the point of inoculation. Feeding experiments have been unsuccessful. The incubation period in animals varies from several hours to several days. The symptoms observed in inoculated animals are, in the main, those of the disease in man, the spasms beginning with the muscles nearest the seat of inoculation. The disease is due to absorption of the toxic products of the organism from the wound which contains them. A study of the tetanus toxin shows that it is extremely poisonous, and that its introduction into the body is followed by the development of tonic spasms. The exact chemical nature of the toxin is unknown. Artificial immunization of animals against tetanus has been studied, and by the injection of progressively increasing doses of tetanus toxin a moderate immunity may be produced. Inoculation of animals with attenuated cultures has also been followed by immunity. The degree of immunity acquired exists for several months. The immune serum protects susceptible animals against tetanus. It is especially efficient if injected before or soon after the inoculation, the degree of success depending largerly upon the time that has elapsed since inoculation. When the symptoms of the disease are fully manifested, success is assured in only a small number of cases. There is no evidence that the antitetanic serum inhibits the growth of the bacilli.

Although tetanus may occur anywhere, it has not everywhere been observed with the same frequency. It is more common in hot than in temperate climates, and in the colored than in the Caucasian race. Lombard states that in Iceland one-third of the general mortality, especially in the newly born, is from tetanus. It has been studied in epidemic form in infants (trismus nascentium). Out of 17,650 infants born (before 1882) in the Rotunda Hospital, Dublin, Clarke estimates that 2944 died of tetanus. In some of the West Indian Islands more than 50 per cent. of the mortality among the negro children has been due to this cause. Formerly the disease was very prevalent on the eastern end of Long Island.

Although cases of idiopathic tetanus are reported, it is probable that the disease is always traumatic in origin. The wound of inoculation is sometimes too small to be found. Of 1751 cases of tetanus, 41.5 per cent. followed wounds of the hand or foot, many of which were the result of injuries from toy pistols; wounds of the limbs, face, and scalp are next in frequency. Infection is more apt to occur after punctured and contused than after incised wounds.

Pathologic Anatomy.—The lesions are few and not characteristic. The recorded autopsies mention inflammation and degeneration of peripheral nerves, meningeal hemorrhages, and inflammatory changes in the sympathetic nervous system. Goldscheider and Flatau have described changes in the motor cells of the anterior horn which they consider characteristic. The cerebrospinal fluid in cases of tetanus has been shown by Stintzing to contain tetanus toxin. This author sums up his research concerning the pathogenesis of the infection in the following: "The tetanus bacillus produces toxins at the seat of infection. These toxins get partly into the circulation (in animals surely), and may become active through this channel; as a rule, however, the toxins are carried along the nearest nerves, presumably in the meshes of the perineurium and endoneurium, to the spinal cord. On reaching the subarachnoidal space of the cord they produce in animals their toxic action, at first at the point of entrance into the cord, and so cause the 'local' tetanus. If sufficient poison is brought to the spinal cord, it produces, next, a reactionary and, finally, general tetanus."

Symptoms.—Most of the cases have an incubation period of about ten days; certainly four-fifths of the cases develop symptoms before the fifteenth day. Acute, chronic, and cephalic forms of tetanus are described.

In *acute* tetanus the onset may be abrupt, but more often malaise, headache, or chilly feelings or actual rigors occur, with some stiffness in the neck or a feeling of tightness in the jaws. Tonic spasm of the masseters (lockjaw) generally develops, and the eyebrows may be raised and the angles of the mouth drawn out, so that the face assumes the so-called sardonic grin—*risus sardonicus*. Finally, the muscles of the whole body may be affected, but those of back are most involved, so that during the spasm the body may be thrown into condition of opisthotonos. Flexion to one side, pleurosthotonos, is less common. Forward bending, emprosthotonos, is seldom seen. The arms, as a rule, are less affected. Paroxysms last a variable time, during which there may be spasm of the glottis, dyspnœa, and cyanosis. The paroxysms often are associated with agonizing pain. Usually the patient is covered with perspiration. Fever may be absent, slight, or in some cases the temperature reaches 105° or 106° F. The mind is not affected. Death generally occurs during a paroxysm, either from heart failure or asphyxia; in other cases it may be due to exhaustion. The disease is usually fatal in about ten days.

In *chronic* tetanus the symptoms are essentially the same as those observed in the acute form, but less severe. The disease may be prolonged for weeks.

Cephalic tetanus is characterized by stiffness of the muscles of the jaw and paralysis of the facial nerve on the same side as the injury.

Diagnosis.—In well-developed cases there is little chance for errors in diagnosis. In strychnine-poisoning the involvement of the jaw muscles, if present at all, appears late, and between the paroxysms there is no rigidity.

Prognosis.—The prognosis is based mainly on the period of incubation and the severity of the symptoms. Statistics show that when the period of incubation is less than ten days the mortality is very high (85 per cent.); and also that the prognosis improves with each day beyond this period. Since the introduction of the antitoxin treatment the mortality has been reduced from about 90 to 40 per cent.

Treatment.—In this we should endeavor (1) to destroy the bacteria at the seat of infection and thereby prevent a further production of toxins; (2) to eliminate from the body the toxins already absorbed from the primary lesion; (3) to neutralize and render innocuous the poison already absorbed; (4) to immunize the body after infection has taken place; (5) to overcome the symptoms induced by the action of the toxins. Thorough disinfection of the wound is very important. The object should be not only to destroy the tetanus bacillus or its spores, but also saprophytic and pyogenic bacteria, which the experiments of Vaillard and Rouget have shown to favor development of the tetanus bacillus. Of the antiseptics most frequently used may be mentioned: (*a*) Bichloride of mercury solution (1: 1000), to which has been added 5 per cent. tartaric acid or 0.5 per cent. hydrochloric acid; (*b*) carbolic acid solution (2 per cent.); (*c*) kresol solution (1 per cent.). Still more efficient is cauterization of the entire wound, either with the actual cautery or with a strong solution of iodine or silver nitrate.

Although the results following the use of tetanus antitoxin for curative purposes were rather disappointing when its administration was confined to the subcutaneous and intravenous methods, recent procedures involving the direct contact of antitoxin and the part of the nervous system affected, have yielded results which are far more promising. While the intracranial method of Roux and Borrel, and the subarachnoid injection method of Jacobs, bringing the antitoxin into direct contact with the surface of brain and spinal cord respectively, proved somewhat more efficacious than the former methods, it remained for Meyer and Ransom to discover the intraneural method of injection which has yielded the most favorable results. By injection of the nerve above the point where it has been exposed to the tetanus toxin the progress of the toxin along the nerve is blocked and tetanic convulsions do not occur. Rogers first applied this method clinically, his method being to inject 10 to 20 c.c. of antitoxin subcutaneously in the neighborhood of the wound; 10 to 20 c.c. intravenously, and 5 to 20 minims in the nerves of the axillary plexus, if the wound is in the upper extremity, or into the crural, sciatic, and obturator nerves if the wound is in the lower extremity. He also injects 20 to 30 minims directly into the cord between the sixth and seventh cervical vertebræ in desperate cases. In view of the fact that tetanus toxin has a strong affinity for brain tissue, and may be *anchored* by it, Krokiewicz suggested the injection of a fresh emulsion of brain-tissue in the neighborhood of the wound. The results by this method have compared favorably with those by the intraneural method. Though not a specific for tetanus, by inhibiting convulsive seizures and conserving the patient's store of energy in this way, as well as by eliminating pain, the injection of magnesium sulphate subdurally into the spinal canal, as suggested by Blake, has been used. This method was successful in one case treated by Blake, who suggests a dosage of 1 c.c. or less for every twenty-five pounds weight in children, and not less than one cubic centimetre for every twenty pounds in male adults. Too large a dose may produce respiratory paralysis.

Blake considers this method as an important adjunct as a preliminary to injection intraneurally and operative measures at the site of the wound through which the infection has been introduced.

In addition to the use of tetanus antitoxin, every effort must be made to prevent the occurrence of convulsions by the maintenance of absolute quiet and the administration, when necessary, of bromides, chloral, morphine, or opium.

Hydrophobia.

Hydrophobia is an infectious disease, occurring chiefly among the carnivora, especially the dog and wolf. The disease is also known as rabies and lyssa. Infection is carried by the bite of a rabid animal or by a wound being licked by such.

Etiology.—Rabies occurs in all countries. In man the period of incubation varies from fifteen days to seven or eight months or longer, but the average period may be taken as forty days. The differences in the incubation period are partly due to the age of the patient, the part involved, and the severity of the wound. In children the period of incubation is more brief than in adults. Wounds, especially punctured, about the face and head are regarded as especially dangerous. The bite of the wolf is more serious than that of other animals.

The infective agent in the saliva of the rabid animal passes through the wound, and is carried along the nerves to the central nervous system. It may be present in the saliva of the dog from three to five days before the symptoms of the disease appear in the dog.

In 1903 Negri found in the ganglion cells of the Hippocampus major (Ammon's horn), cerebral cortex, medulla, and elsewhere in the nervous system rounded bodies 1 to 23 μ in diameter resembling protozoa, which stain readily and consist of a rounded or oval homogeneous basement substance containing a central body surrounded by variously shaped granules.

These "Negri bodies" have been found in nearly all cases of street rabies examined for them, and in no infective or other disease than rabies, and therefore undoubtedly occupy a specific etiological relationship to hydrophobia.

Morbid Anatomy.—The lesions are limited to the central nervous system. In the medulla and pons, and occasionally in the spinal cord, may be seen small hemorrhages, accumulation of leucocytes in the perivascular spaces about the bloodvessels and ganglion cells. Some of the ganglion cells show chromatolysis, and the Negri bodies may occupy central or peripheral positions in them.

Symptoms.—Three stages are described. First, prodromal, in which there may be pain in the wound and in the nerves along the injured limb. Manifestations of nervous irritability soon appear, associated with an increase in the reflexes. There may be slight fever. The patients at this period are often melancholic, and there may already be some suspicion of difficulty in swallowing. Second, stage of excitement, in which there are great excitability and hyperæsthesia. There are spasms, especially of the muscles of deglutition and respiration. Delirium may be present. Spasms may be induced by the slightest causes. In the intervals the patient is clear minded and calm. The temperature is between 95.5° and 102° F. In two or three days the patient passes into the third or paralytic stage, in which the reflexes are diminished, weakness and paralysis may be present, convulsions occur, and finally coma and death supervene. The duration of the disease is from five to ten days. Death invariably results when once the disease is established.

Whenever a person is bitten by an animal that is suspected to be suffering from rabies, the animal may be carefully watched for manifestations of the disease. Death will usually take place within five days. If the animal has been killed, pieces of the cord or medulla may be taken and inoculated beneath the dura of a rabbit. Symptoms will appear within three weeks. Recently it has become the common procedure to kill the suspected animal and determine the diagnosis of rabies by the presence of Negri bodies in the brain or medulla. In this way a positive diagnosis may be made with the least loss of time.

Treatment.—Before Pasteur's method was developed, the only means by which the development of the disease could be prevented in those who had been bitten by a rabid animal was cauterization of the wound. The technic of immunization is as follows: A number of rabbits are inoculated beneath the dura with portions of the spinal cords of rabid animals. By drying these cords, after removal from the rabbits, in the air, the virulence of the rabic virus which they contain diminishes day by day. Emulsions of these cords are injected into patients threatened with rabies—first using the "fourteen-day" cord, which is almost inert, followed daily by emulsions of the cords containing stronger virus until the "one-day" cord is used. In this way the strong virus may be safely administered and artificial immunity is conferred against the disease.

Immunization must be complete before the disease has begun to manifest itself, or the treatment may be of no avail.

By this method of protective inoculation the mortality from rabies has been reduced from 16 to 0.48 per cent.

Anthrax (Malignant Pustule, Wool-sorters' Disease.)

Anthrax is an acute, local, or general infectious disease, induced by *Bacillus anthracis.* It occurs with great frequency among the herbivora, especially sheep and cattle, from which it is readily communicated, directly or indirectly, to man.

Etiology.—It is to the studies of Rayer and Davaine, Pollender, Pasteur, and Koch that we owe our knowledge of the infectious agent of anthrax. The anthrax bacillus occurs as a rod from 2 to 25 μ long and about 1.2 μ thick. It is non-motile and readily forms spores, which are very resistant to heat and chemical agents. They are not killed, except after prolonged immersion in 5 per cent. carbolic acid, and withstand the temperature of boiling water for several minutes. They are not killed by gastric juices. Outside of the body the spores probably live for a long period of time. The bacillus grows well on the ordinary media.

Anthrax is more commonly met with in Europe and Asia than in this country. Animals are sometimes inoculated by the bites of insects, but more often by swallowing the infectious agent. Those who are engaged in handling hides are often infected on the hands or face. Butchers sometimes are infected by handling contaminated meat. Wool-sorters, on the other hand, are more liable to inhalation infection.

Symptoms.—Several varieties of the disease are recognized, according to the portal of entry of the anthrax bacillus. The infection may be *external,* through the skin; *internal,* through the respiratory organs or intestine.

The characteristic lesion of the external form is the *pustule,* which is usually situated on the hands, arms, face, or neck. The period of incubation is two or three days. The external lesion begins as a papule, which soon becomes vesicular. The tissues become infiltrated with exudate, so that within forty-eight hours there is a dark-brown or brownish-red eschar, often surrounded by a fine vesicular eruption. The lymph-nodes of the region become enlarged and painful. There is a variable amount of fever, although the temperature may fall to subnormal before death occurs. Death may occur within three or four days. In the majority of anthrax infections the symptoms are less severe. In these cases there may only be slight swelling about the local lesion.

The disease sometimes appears, especially about the face, as an extensive edema without papules or vesicles. This is known as *malignant anthrax edema*. The fatal cases of external anthrax are generally those in which infection has taken place on the face or neck.

Intestinal anthrax results from swallowing infected material. There may be a chill, often followed by diarrhœa, fever, and other evidences of an acute infectious disease. The spleen is enlarged. The bacilli may be found in the blood shortly before death. In the *respiratory* type the symptoms are usually severe from the beginning—chills, pain in chest, back, and legs, hurried respiration, fever, and cough, with signs of bronchitis. Death may occur within thirty-six hours.

The outlook is best for cases of external anthrax, especially if the infection occurs in the extremities. In this class the mortality does not exceed 5 per cent. When the lesion is on the neck or face the mortality rises to about 30 per cent. Internal anthrax shows a much higher mortality.

Treatment.—The primary lesion in its earliest stages may be destroyed by the Paquelin cautery or caustics. Wide excision is, however, the method of choice. This should be practised at the earliest possible moment, and if the neighboring glands are involved they should be removed. Disinfection of the wounds by means of packing with wet formalin gauze (1: 50) is the most effective treatment. The toxæmia should be combated with stimulants, food, and measures to promote rapid elimination of the poison through the skin, kidneys, or alimentary canal.

Malignant Edema.

Malignant edema is an acute, local, infectious process, accompanied by tissue emphysema and gangrene, and caused by the *bacillus of malignant edema*, which is found in garden soil, dung, and various putrefying substances.

The bacillus is anaërobic, occurs as long, thick rods, with rounded ends, singly or in long filaments. Under unfavorable conditions of growth the bacillus develops large spores, which have a very high power of resistance. It is not stained by Gram's method.

The infection may be introduced by a sharp-pointed garden tool or even a needle, but the disease occurs most commonly when dirt containing the bacillus enters a severely contused wound with the crushing of the tissues.

Early in the process the skin becomes a dirty, brownish-red color, with distended veins filled with stagnating blood. The tissues become edematous and infiltrated with gases, giving rise to emphysematous crepitation on palpation. A scant serosanguineous discharge exudes from the wound, accompanied by a characteristic, offensive odor. Gangrene develops in the wound and spreads rapidly. The neighboring lymph-nodes are swollen and the patient shows signs of septic absorption—fever, prostration, dry, heavily-coated tongue, rapid pulse, with delirium followed by coma. Death may occur in from forty-eight hours to three or four days, an entire extremity being meanwhile involved in the disease.

Prognosis.—The prognosis is bad. The mild cases occasionally recover after multiple incisions and continuous irrigation with antiseptics; but amputation performed early and as high up on the extremity as possible, is usually indicated.

In animals, immunity to this infection has been produced by repeated injections of sterilized or filtered cultures of the organism or the filtered serum from immune animals.

Glanders (Farcy).

Glanders is an infectious disease which chiefly affects horses, mules, and asses. It is found also in man as a result of direct inoculation on some wound of the skin or other part with the discharges or diseased tissues from an affected animal. Therefore it is especially frequent among grooms and others whose work brings them into contact with horses.

Etiology.—The bacillus of glanders was discovered by Loeffler and Schutz. It is a non-motile rod, straight or slightly curved, and of about the same length as the tubercle bacillus. It is not definitely known whether or not spores are formed. The organism stains with simple watery solutions of the basic stains ; especially good results are obtained with carbol-thionin. Artificial cultivation is readily accomplished.

Morbid Anatomy.—When limited to the nose the disease is called *glanders ;* but if present beneath the skin, it is designated *farcy.*

The lesions consist of granulomatous tumors, which tend to break down rapidly and form ulcers on mucous membranes and abscesses beneath the skin. The lungs are almost invariably involved. Less frequently other organs show characteristic lesions. These consist of larger and smaller white or yellowish-white nodules sharply circumscribed and surrounded by a hemorrhagic zone. Beyond this an area of pallor is sometimes seen. They are situated around the bloodvessels, and consist of polymorphonuclear leucocytes with broken down cells.

Symptoms.—Glanders infection in man is either acute or chronic in its manifestations.

Acute Glanders.—The incubation period is generally three to four days. At the inoculation seat there are swelling, redness, and signs of lymphatic involvement. In three or four days the nodules in the mucous membranes of the nose begin to break down, with the discharge of muco-pus. There is considerable swelling of the nose, and an eruption of papules and pustules is common on the face. The lymph-nodes of the neck are usually swollen. The disease runs a course of about ten days, many of the cases dying with pneumonia. All the cases terminate fatally.

Chronic Glanders.—This may last a long time, and the diagnosis is not often made. The symptoms are those of a chronic coryza. Ulcers may be found in the nose.

Acute Farcy.—This is the result of inoculation into the skin. Intense local inflammation occurs ; the lymphatics become involved, and along their course nodules—*farcy buds*—may be felt. Many of these suppurate. In addition to these lesions there is often a pustular eruption resembling that of varicella. The disease pursues a febrile course like that of severe typhoid or a septic infection. Pains and swellings in the joints may be present. The nasal mucous membrane is free from ulcers. The prognosis is bad, most of the cases dying within two weeks.

Chronic Farcy.—In this form the nodular tumors are usually found in the extremities. Many of them break down, resulting either in abscess or ulcer formation. The lymphatics are not specially involved. Recovery is possible.

Diagnosis.—The diagnosis may be made by Straus' inoculation test. It consists in the peritoneal inoculation of male guinea-pigs with suspected material. If the inoculated material contain *Bacillus mallei* there will be swelling of the testes as early as the third day, and swelling and ulceration of the scrotum by the fifth or sixth day. Autopsy often shows the presence of glanders nodules in the omentum, spleen, and liver, and an inflammatory purulent or caseous exudate in the tunica albuginea. Mallein—the glanders bacillus toxin—is now used for diagnostic purposes in horses.

Treatment.—The lesion should either be excised or cauterized if the case is seen early. The farcy buds should be opened and disinfected with formalin.

Bacillus Aerogenes Capsulatus (Gas Bacillus) Infections.

It is known that various bacteria may be concerned in producing gas in tissues where it does not normally exist. From the investigations of the last ten years, however, we know that *Bacillus aërogenes capsulatus*, which was discovered by Welch in 1891, is the one most frequently associated with such conditions. This is a rather coarse, often encapsulated, non-motile anaërobic bacillus, staining by Gram and growing on all the ordinary media under anaërobic conditions. Spore-formation is inconstant. It forms gas by fermentation of sugars and proteids. The natural habitat of the organism is the soil and intestinal canal. Brooks has also found it in the male urethra, the vagina, and nasal cavities. It is common experience to find the bacillus in cadaveric decomposition; its natural occurrence in the intestine explains this phenomenon. Bacillus aërogenes capsulatus has been observed under a variety of pathologic conditions associated with the formation of gas in the tissues. It may also induce septicæmia, in which gas bubbles are found in the blood. The presence of these gas bubbles in organs give an appearance which is commonly designated *foamy organs* (Schaumorgane). Gas-bacillus infection often follows wounds to which dirt has gained access, such as compound fractures and injuries of different kinds. Sometimes, as noted by Bloodgood, the organism does not lead to gas formation in the involved or other tissues. Frequently, however, it induces *emphysematous gangrene*, most of the cases involving the extremities. Gas may appear in the tissues as early as eight hours after the injury. The lesions consist of necrosis, gaseous distention of the tissues, infiltration with blood, and the exudation of serum. The majority of the cases die from the results of general infection. On the other hand, when the disease is promptly and adequately treated, recovery may occur. Of the cases collected by Welch, 59 per cent. terminated fatally.

Gas-bacillus infection may also occur in the genito-urinary organs, especially in pregnant and puerperal women, particularly after abortion. Gastro-intestinal and other forms of infection have been described.

Diagnosis.—The disease generally begins as any other cellulitis. It differs from the ordinary form of cellulitis, however, by its rapid extension, the presence of a crackling sensation on pressure, and the rapid development of grave septic symptoms. The presence of emphysema in the tissues will, of course, always excite suspicion. It is important in such cases to make cover-slip preparations with material from the infected parts. The presence of rather large, straight, or slightly curved bacilli, which stain, by Gram, especially if capsulated, is very suspicious. This should be further confirmed by introducing some of the infected material into the circulation of a rabbit, preferably into one of the ear-veins. After a delay of about ten minutes, which is necessary to insure distribution of the injected material throughout the body, the animal should be killed and placed in a warm room or incubator. In a few hours examination, if *bacillus aërogenes capsulatus* be present, will reveal the characteristic appearance of "foamy organs."

Treatment.—The treatment consists of free incisions, removal of the gangrenous cellular tissue, and packing the wounds thus formed with wet formalin gauze (1 : 50). Stimulants, an abundance of nourishing food, and measures to favor rapid elimination of the toxins also are indicated.

Gangrene.

The term *gangrene* is applied to the process resulting in the death of tissue *en masse.*

Etiology.—The causes may be divided into : (1) *Exciting*, which consist of agents directly destroying the vitality of the tissues, or of those which act directly by cutting off their nutrient supply ; and (2) *predisposing* causes. Some exciting causes are in themselves alone capable of causing gangrene. For others, however, to become operative, predisposing causes which impair the vitality of the tissues are necessary. These are old age, feeble action of the heart, chronic congestion of a part, deteriorated blood, as in diabetes and Bright's disease, and the impairment or loss of nerve influence from injury or disease of the nerve centres or nerve trunks.

Of the exciting causes those which act directly by destroying the vitality of the tissues are : *chemical,* as strong acids or alkalies ; bacterial toxins and animal poisons ; *mechanical,* as severe crushing of a part ; and *thermal,* as extremes of heat and cold in burns and frost-bites.

Those causes which act indirectly by cutting off the nutrient supply of tissues are *obstruction to the arterial supply,* as from ligature, embolism, thrombosis, arterial sclerosis, or spasm of arterioles due to long ingestion of ergot ; *obstruction to the capillary circulation* from thrombosis or pressure, as in bed-sores or pressure from a splint or new growth ; *obstruction to the venous return,* as in strangulated hernia, paraphimosis, tight bandaging, etc.

Clinically, gangrene may be divided into *dry* and *moist* forms.

The amount of fluid in the tissues at the time gangrene supervenes and the degree of bacterial infection, being the factors which influence the type of the process, and as these factors are variable, there is no distinct dividing line between the two forms. Characteristic types and extreme degrees of each may frequently be observed, however.

The clinical types of gangrene which are usually dry are senile, gangrene from embolism or ligature of a main artery, frost-bite, and Raynaud's disease. The others, which are moist, are inflammatory, traumatic, hospital and diabetic gangrene, phagedena, bed-sores, carbuncle, cacrum oris, and noma.

Symptoms.—In the dry form of gangrene the onset and development are very slow. The part first becomes pale and mottled, then dry, shrivelled, and hard, turning to a brown or black color and resembling a mummy. The surface is often oily. As bacterial processes are not here active there is no putrefaction, and the odor, so offensive in moist gangrene, is absent.

In the *moist* form of gangrene the tissues, at the onset, are full of blood and fluid, the process is rapid, with little time for the evaporation of fluids, and bacterial activity is pronounced and often extreme. During the early stages the part becomes swollen, dusky red in color, edematous, and painful. Later all sensibility is lost, it becomes colder than natural, and the color changes to a dark greenish-purple tint, and then becomes black. Bloody bullæ form and the epidermis peels off, leaving a moist surface. Putrefactive gases collect in the tissues and cause crepitation when the part is pressed. The soft parts become semisolid or liquid, and separate from the bone as a slimy, foul-smelling dark mass.

As a result of the absorption of septic products the patient may have fever, often of the asthenic type, resulting in exhaustion or death.

These two forms may result in the formation of a *line of demarcation*, or a progressive advance with no definite limitation.

In the latter case, occurring most commonly in spreading traumatic gangrene, the process advances rapidly up an extremity reaching the trunk, when the patient falls into a typhoid condition and dies. No line of demarcation forms and operative treatment consists of amputation, early and far removed from the injury. There is a great tendency in these cases for gangrene to occur in the flaps after amputation.

When a line of demarcation forms, either in the moist or dry types, it is caused by an inflammatory process set up as the result of the irritation of the dead tissues. This results in suppuration and granulation; a furrow, containing pus, forms between the dead and living parts, deepens, and finally entirely separates the two, leaving a surface from which the gangrenous part has become detached, covered with granulation tissue.

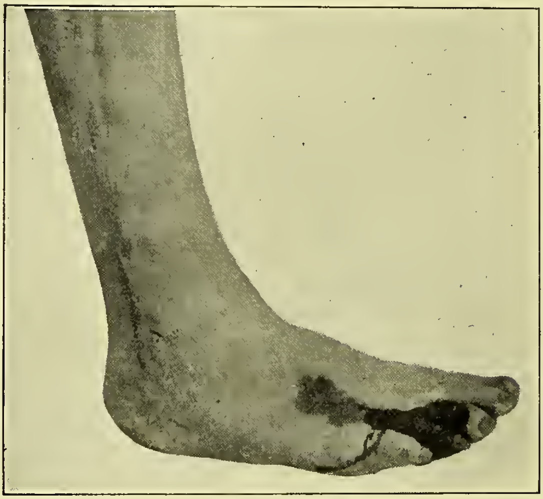
Treatment.—While the details of the treatment of gangrene must vary with the type of the process and its cause, the following general principles may be adhered to in all cases:

(1) Remove, where possible, the cause.

(2) Combat threatened gangrene by maintaining the warmth of the part, improving the circulation by elevating the limb, and by gentle friction where there is venous congestion.

(3) When gangrene has actually occurred, check its spread if possible; promote separation of the dead from the living part or remove it by amputation; control, as far as possible, the formation of the products of putrefaction by keeping the part dry and by the free use of antiseptics; support the patient's strength, counteract the deleterious effects on the constitution from the absorption of the septic poison, and soothe the pain by opium.

Fig. 5.



Senile gangrene of foot.

Although the general outline of symptoms and treatment already given are applicable for most of the forms of gangrene, a certain amount of variation occurs in the various clinical forms of gangrene which necessitate brief mention.

Clinical Types.—**Senile Gangrene.**—Senile gangrene, rarely occurring before sixty years, is usually caused by a narrowing of the arterial lumen as a result of advanced *sclerosis* in connection with weak heart action, the process frequently having its origin in some slight local injury. It usually starts in the toes, and may extend to the ankle or knee before a line of demarcation is formed. The gangreneous extremity may then be cast off or the patient may succumb from exhaustion and septic absorption. The affected parts are occasionally allowed to separate spontaneously. The greatest care is employed to cleanse the part with an efficient antiseptic and keep it surgically clean thereafter. Dryness is essential, and after an antiseptic deodorizing powder is applied the part is wrapped up in a thick layer of absorbent antiseptic gauze.

Amputation, if resorted to, is usually done above the bifurcation of the popliteal artery, as the chief obstruction is often situated at this point. The age and condition of arteries and heart in these patients, however, make the conditions for operation far from favorable.

Pre-senile Gangrene.—While it has long been recognized that senile gangrene occurs most commonly as the result of interference with the nutrition of a part through the diminution of the blood-supply following arteriosclerosis, it is only recently that the fact has been appreciated that arteriosclerosis may occur in earlier life to operate similarly as a cause of this form of gangrene.

To this process, occurring in the young, the term pre-senile gangrene has been applied.

This form of gangrene, like the senile, is apt to be dry, and, with the exception of the age of the patient, differs in no essential way from the senile form, except that the prodromal symptoms may exist for months or years before complete gangrene finally occurs as a result of thrombosis in the narrowed lumen of the affected vessels.

Ischæmic Gangrene.—In gangrene due to *embolism*, *thrombosis*, or a *ligature*, the extent of the process depends upon the site of the exciting cause; and the process is usually of the dry type.

In these cases it is necessary, before resorting to amputation, to wait until an arrest of the process takes place. By this means the proper site for amputation is best determined, and an opportunity is given to the collateral circulation to establish itself in the tissue which is to be used for flaps.

Gangrene from *frost-bite* is usually seen in the fingers, toes, ears, and nose. It is usually typical of the *dry* type. The treatment in the early stage consists of rubbing the part with snow or cold cloths, gradually making the applications warmer. Elevation of the part, warm, loose bandaging, warmth, and general stimulants are then employed. If gangrene has completely developed, the part may be kept dry, dusted with an antiseptic powder, and allowed to separate at the line of demarcation, or removed by amputation.

In *Raynaud's disease*, caused probably by some disturbance of the vasomotor nerve-center inducing spasm of the arterioles, or in some cases by a peripheral neuritis, the parts, generally the fingers, become first white, cold, and insensitive, then swollen, red, dusky and painful, and later black, the process, if continuing further, terminating in dry gangrene. Until the last stage is reached relief may be obtained by local warmth and loose bandaging, the constant descending electric current, or placing the parts in an electric bath, with the use of general tonics.

Ergot gangrene occurs from *tetanic contraction* of the arterioles, produced by the contamination of rye bread with *claviceps purpurea.* The process, which attacks the fingers, ears, or nose, is preceded by formication, numbness, and pains in the parts affected. It is advisable to wait for the formation of a line of demarcation before operating on these cases, and then to amputate immediately above the disease.

Carbolic Gangrene.—*Carbolic acid,* even in comparatively weak solutions of 2 to 4 per cent., is liable to induce *dry* gangrene when applied as a moist dressing to the fingers or toes for a prolonged period of time.

Before amputation is done a distinct line of demarcation should present itself, and in some instances the dead tissue may be allowed to separate naturally from the living, the bone being then nipped off high up with forceps.

Traumatic Gangrene.—*Acute spreading traumatic* gangrene is an example of *moist* gangrene occurring in tissues which have been badly crushed and lacerated and infected with virulent pathogenic microbes. These are often anaërobic and sometimes gas-producers, and include the bacillus aërogenes capsulatus, bacillus of malignant edema, and colon bacillus, all of which are capable of manufacturing excessively toxic products. The process is exceedingly rapid, putrefactive gases in the tissues may give rise to emphysematous crackling, and the course of the lymphatics may be traced by red lines in the superficial tissues. The edges of the wound are swollen, everted; there is a slight, fetid discharge of brownish serum, but no pus.

All such wounds should be thoroughly cleaned, trimmed free of tissue shreds, the crevices well drained, exposed to air, and washed with hydrogen peroxide.

Gangrene once having developed, the patient's only hope lies in immediate amputation as high as possible above the gangrenous part, strict antisepsis of the field of amputation being maintained. To combat the overwhelming constitutional effect of the absorbed toxines stimulants should be administered.

Closely allied to this form of gangrene is the type known as *inflammatory* gangrene, or *gangrenous cellulitis,* occurring usually in the subcutaneous tissue as a result of infection by the Streptococcus pyogenes. The tissues, which usually have a low, resisting power in these cases, die as a result of tension and bacterial toxines. The condition may progress rapidly, and the exudate after incision may be serous without any evidence of pus.

Treatment must be prompt and energetic, consisting of multiple free incisions followed by copious antiseptic irrigations. Failure to stem the advance of the process by these means must be followed by amputation. The constitutional effect of the absorbed toxin is to be combatted by the use of stimulants and antistreptococcus serum.

Very closely allied to these forms are *cancrum oris* and *noma*, occurring as sloughing ulcers in the mouth and vulva respectively, as a result of capillary thrombosis caused by virulent bacterial infection in debilitated children after infectious diseases. The treatment for these conditions is the same as that of the phagedenic gangrene just described.

Diabetic Gangrene.—This occurs in diabetics as a result of accompanying endarteritis, disturbance of nerve control, and lowered resistance of poorly nourished tissues containing an increased amount of sugar, by which the growth of bacterial organisms is aided. For this reason diabetic gangrene, which resembles the senile form in many ways, is usually moist.

It usually starts in the lower extremity as a result of a slight wound. It may spread rapidly or slowly.

If the spread is slow, the process should be treated expectantly by local measures. If the advance is rapid, amputation at the lower third of the thigh should be performed.

In the meantime measures directed toward the constitutional condition of diabetes should be employed with special reference to the avoidance of diabetic coma following operation.

Bed-sores occur in those whose tissues are partially devitalized by acute fevers and chronic diseases, especially of peripheral nerves or nerve centres.

The direct cause is usually pressure over a bony prominence. The skin becomes a dusky-red color, purplish, and finally black. A slough forms which separates, and the process may extend centrifugally or deeply until it reaches periosteum or bone.

Prevention of the condition is most important by the regular changing of the patient's position, the use of ring pads and air cushions, thorough cleanliness, rubbing with alcohol, drying, and the application of antiseptic dusting-powders.

The ulcers, once formed, are to be treated by antiseptics and regular surgical methods.

CHAPTER IV.

CHRONIC INFECTIOUS SURGICAL DISEASES.

Tuberculosis.

TUBERCULOSIS is an infectious disease common to man and certain animals. It is caused by *Bacillus tuberculosis,* and is characterized by an exudative and productive inflammation in which necrosis and caseation of the involved tissues commonly occur. The typical morphologic lesions consist of small nodular growths, called *tubercles.*

Bacillus Tuberculosis.—The contagious idea of phthisis dated back to the time of Galen, who included it among those diseases which could be communicated from one subject to another. In the latter half of the fifteenth century the belief occupied a prominent position in the minds of many in Italy, judging from the sanitary regulations then in force with reference to the disease. But it remained for Villemin to establish definitely, by experimental studies, its infectious nature. His first communication appeared in December, 1865. For the discovery of the inciting agent we are indebted to Koch, whose announcement appeared March 24, 1882.

The *tubercle bacillus* is a short, slender rod, often slightly curved. It measures from 1.5 to 3.5 μ in length. Stained specimens frequently show a beaded appearance, which some have attributed to spores. Branching forms sometimes are seen. The tubercle bacillus takes up the ordinary stains slowly. The staining is accelerated by heat. When stained, the organism retains the dye after treatment with acids. One of the best and most convenient methods is the Ziehl-Neelson method. The cover-glass is preferably floated in a watch-crystal, with the specimen side down in the carbol-fuchsin solution (basic fuchsin, 1 part; absolute alcohol, 10 parts; watery solution of carbolic acid (1 : 20), 100 parts), gently heated to steaming for three or four minutes. After heating, the excess of the dye is washed off with water and the specimen is placed in 5 per cent. aqueous or alcoholic solution of sulphuric acid. When the color disappears the specimen is washed in 60 or 70 per cent. alcohol, and finally in water. Counterstain with 1 per cent. aqueous solution of methylene-blue. The tubercle bacilli will be stained red and other bacteria blue. Artificial cultivation is accomplished best on blood-serum and other media to which glycerin has been added. It grows best at body temperature, and colonies begin to appear in two weeks. The colonies form dull, grayish-white scale-like masses on the surface of blood-serum. The tubercle bacillus is non-motile, does not form spores, and grows best in the presence of oxygen. Dried tuberculous sputum may contain living tubercle bacilli after many months. The organism is readily killed at high temperatures; its viability is also affected by desiccation, putrefaction, and sunlight. Five per cent. carbolic acid kills the organism in thirty seconds; 1 : 1000 solution of mercuric chloride in ten minutes; and absolute alcohol in five minutes.

Tuberculosis has been well studied experimentally in animals. Guinea-pigs are very susceptible to inoculation with cultures or material containing tubercle bacilli. Variations in virulence have been noted. Tubercle bacilli obtained from cold-blooded animals, or from cattle, or birds show cultural and pathogenic differences from those of human derivation.

Distribution of Bacilli.—They are present in all tuberculous lesions, although their demonstration may sometimes be very difficult. In actively developing tubercles they are present in great numbers; but in some lesions, such as tuberculosis of lymph-nodes and joints, they are generally present only in small numbers. Outside of the human body the organism is also widely distributed. This is not surprising if we recall the estimate of Nuttall that the twenty-four hour sputum of a consumptive patient may contain between 300,000,000 and 4,000,000,000 tubercle bacilli. In its moist condition sputum is devoid of great danger, but in drying it is eventually converted into dust that is spread in all directions by currents of air. Perhaps nothing more forcibly emphasizes the danger of infection from such sources than the investigation of Straus, who demonstrated the presence of bacilli in the nasal mucus of various healthy individuals frequenting the wards of hospitals in Paris. Cornet showed that the dust from the floors and walls of dwellings in which tuberculous persons were living often contained virulent tubercle bacilli; and Hance found that the dust of one in five cars was contaminated with them. It has repeatedly been shown that the meat of tuberculous cattle may contain living tubercle bacilli; the same is true of milk. Baldwin has recently shown that tubercle bacilli are not uncommonly present on the hands of tuberculous patients who are not careful in the use of handkerchiefs, clothing, or cuspidors.

Histology of the Tubercle.—The local lesions induced by the tubercle bacillus are often in the form of circumscribed nodules, which are called *tubercles.* Such localized tuberculosis may remain as a local inflammation; or by metastasis it may give rise to the development of tubercles in other parts of the body. The tubercles are small nodular bodies, either gray and translucent, white or yellow, and opaque.

The action of the tubercle bacillus in the body is twofold : on the one hand it induces proliferative changes and leucocytic emigration; and, on the other hand, it causes degenerative changes which result in necrosis. The earliest reaction consists in proliferation of the connective-tissue and endothelial cells. These become changed into polyhedral cells with vesicular nuclei—*epithelioid cells*. Leucocytes, chiefly polymorphonuclear, accumulate about the focus of infection; but as the tubercle grows the leucocytic emigration changes to mononuclear (lymphocytes). Hand in hand with these changes new reticulum is formed. Giant cells are frequently present. Old bloodvessels are usually obliterated and new ones are not apt to form. With the elaboration by the tubercle bacilli of poisonous products which act upon the cells, a process of coagulation necrosis, or caseation, develops. This begins in the centre, gradually extending to the periphery. Partial necrosis of giant cells also is observed. The cheesy masses may undergo softening, fibrosis, or calcification. Under the microscope these typical tubercles usually consist of small round cells, epithelioid and giant cells, and a reticulum. The caseous portion occupies the central part, perhaps with giant cells. Outside of this is a zone of round and epithelioid cells, and beyond this an area made up almost entirely of small round cells. Instead of such focal lesions as tubercle, large areas of tuberculous inflammation may develop, showing more or less caseation with an irregular sprinkling of epithelioid and round cells. But whatever the morphologic character of the lesions, tubercle bacilli are always present.

Occurrence in Various Organs.—Tuberculosis may occur in any organ, but some tissues are more commonly affected than others. Thus the lungs, pleura, lymph-nodes, peritoneum, bones, joints, and testicles are more commonly involved, whereas tuberculosis of the muscles, fasciæ, liver, spleen, ovaries, and pancreas is rare. In adults the lungs may be regarded as the seat of election; and in children the lymph-nodes, bones, and joints. Osler states that in 1000 autopsies 275 cases were tuberculous, with involvement of the lungs in all but two or three. The frequency of involvement of other organs was as follows: Intestine, peritoneum, kidneys, brain, spleen, liver, generative organs, pericardium, and heart. Surgical tuberculosis has a somewhat different distribution. Of 8873 patients of the Wurzburg clinic, 1287 were tuberculous, with the following distribution: Bones and joints, 1037; lymph-nodes, 196; skin and connective tissues, 77; genito-urinary organs, 20; mucous membranes, 10.

It is generally agreed that tuberculosis is rare during the first months of life. Most of the cases occur between the ages of ten and forty.

Modes of Infection.—Certain well-defined forms of tuberculosis are recognized, depending on the point of entrance of the infectious agent.

The common primary localization of tubercle in the lungs indicates that in a large proportion of cases infection takes place by inhalation. The cases of primary intestinal tuberculosis have usually followed the ingestion of infected milk. Secondary lesions in the intestines are common, due largely to the swallowing by consumptive patients of infected sputum. Cases of accidental inoculation have been reported, especially among those working with infected tissues, such as pathologists, butchers, etc. Congenital tuberculosis is very rare; most authorities concede that the tubercle bacilli are transmitted only occasionally from parent to offspring.

Predisposing Factors.—There is general agreement that under certain conditions leading to extreme impurity of the air tuberculosis becomes frequent. Absence of sunlight and ventilation are important predisposing factors. Formerly accorded a most important rôle, inherited predisposition has been less insisted upon within recent years. Those who follow certain occupations have been shown to contract the disease more readily than others. The influence of sex is very slight.

It is generally admitted that an intimate association exists in many cases between trauma and the subsequent development of a tuberculous lesion in or about the injured part. Experience shows that some parts are much more prone than others to develop tuberculosis after injury of this kind. Thus the joints, lungs, and meninges are particularly vulnerable under these conditions. In some cases, on the other hand, generalized tuberculosis has followed injury to tissue in which there was only local tuberculosis. The existence of other disease, by lowering the general vitality, also predisposes to tuberculous infection.

Bacteriologic Diagnosis.—Bacteriologic examination always constitutes one of the most important features in the diagnosis of any case of tuberculosis.

Examination of Sputum.—Preferably the morning sputum is collected. Care should be exercised in selection of the specimen. Frequently nasopharyngeal mucus only is obtained. The fine, cheesy particles should be carefully selected, as they are more apt to contain the tubercle bacilli. Many examinations are sometimes necessary before their demonstration. The Ziehl-Neelson method of staining is best.

Examination of Urine.—In cases of suspected genito-urinary tuberculosis the urine should be obtained by sterile catheterization, centrifuged, and the sediment collected. It is usually very difficult to find tubercle bacilli in urinary sediments. Moreover, unless special precautions are taken, the smegma bacillus, which is normally present about the external genitals, and has tinctorial reactions similar to the tubercle bacillus, may be mistaken for it. For the differentiation of the two organisms use the following method:

Stain with carbol-fuchsin in the usual manner, wash with 10 per cent. solution of nitric or sulphuric acid, and then place in 97 per cent. alcohol for about eight hours. If at the end of this time bacilli be found which are stained red, one may be quite certain that they are tubercle bacilli. The safest way is, however, to have recourse to guinea-pig inoculations, either intraperitoneal or subcutaneous.

Examination of Serous Exudates.—The search for tubercle bacilli in the exudates of tuberculous pleurisy, peritonitis, meningitis, or arthritis is often uncertain and tedious. The exudates are to be removed with bacteriologic precautions and collected in sterile receptacles. Fluid may be obtained from cases of meningitis by lumbar puncture. For microscopic examination it is important to centrifugate the fluid because the tubercle bacilli are almost always present in small numbers. Guinea-pig inoculation is the best test.

Examination of Intestinal Discharges.—The tubercle bacilli are not readily found in stools. Rosenblatt recommends giving laudanum until the stools become hard, and then examining the surface of the masses, particularly any mucopurulent material which may be found on them. In his opinion, the hard scybalous masses, in passing over an ulcerated surface, brush off bacilli and carry them along. Kinghorn, of Saranac, recommends the following: Dilute the dejecta with normal salt solution and allow the solid portions to settle. Pour off the supernatant fluid, which contains the tubercle bacilli in suspension, centrifugate, and stain the sediment. Since other acid-resisting bacteria are known to be sometimes present in the intestine, it would be well to decolorize, as in the case of the examination of urine sediments.

The various forms of surgical tuberculosis will be considered separately in subsequent chapters.

Syphilis.

Syphilis is a specific constitutional disease limited to man, the virus of which may be transmitted by inoculation or by inheritance.

The former is spoken of as *acquired syphilis*, the latter as *congenital syphilis*.

Etiology.—The disease prevails throughout the civilized world, and in time past has presented a far greater degree of virulence than is recognized at present.

Until recently the cause of this disease was unknown ; but in 1905 Schaudinn and Hoffman discovered a slender spiral organism, the *Spirochæte pallida*, which has been found in syphilitic lesions and in these only, and which has been obtained from the scrapings of chancres, enlarged glands, mucous patches, and flat condylomata in syphilitic cases, and may be readily demonstrated in these scrapings, and occasionally in scrapings from tertiary lesions by means of the Giemsa[1] or Goldhorn[2] stains. To demonstrate the organism in tissues the method of Livaditi[3] is usually employed. The spirochæte pallida varies in length from 4 to 14 μ, has from three to twelve curves, and pointed ends.

The virus gains entrance to the body by contact with some abraded surface. As in the great majority of instances this occurs on the genital organs during sexual intercourse, the disease has been generally regarded as a venereal affection. It must be remembered, however, that inoculation may occur at any point and in a great variety of ways, and many examples of non-venereal infection are observed.

Acquired Syphilis.—**Symptoms.**—*Primary Period.*—The seat of inoculation, after a certain period of incubation varying from one to six weeks, presents certain characteristic tissue-changes resulting in the formation of the *chancre* or *initial lesion*. This,

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[1] The smears are fixed in methyl or ethyl alcohol for ten minutes and allowed to dry. The specimen is then allowed to remain in the stain, diluted in the proportion of 1 drop of stain to 1 c.c. of water, from one to twenty-four hours, washed gently, and mounted. Specimens may be stained in fifteen minutes by the addition of from 1 to 10 drops of a 1 : 1000 potassium carbonate solution to the water with which the stain is diluted.

[2] Cover the unfixed smear with the stain for four or five seconds, pour off slowly, and wash gently in water with film side down, for three or four seconds. Allow to dry spontaneously. The spirochæte are stained a violet color.

[3] Tissue sections about 1 mm. in thickness are fixed for twenty-four hours in 10 per cent. formalin, washed and hardened in alcohol for from twelve to sixteen hours, then washed in distilled water until the pieces sink.

The sections are then impregnated for from two to three hours at room temperature in the following fluids :

Nitrate of silver,	1.	
Pyridin,	10.	(added just before using);
Distilled water,	100.	

After washing rapidly in 10 per cent. pyridin, reduce the silver by placing in the following solution for several hours :

Pyrogallic acid,	4.	
Acetone,	10.	(added just before using);
Pyridin,	15.	
Distilled water,	100.	

Harden in alcohol ; xylol ; paraffin.

in the majority of instances, is an elevated indurated nodule, presenting on its surface an area of indolent ulceration. The lesion is, as a rule, single and painless, and is often discovered by accident. In women the initial lesion is often overlooked. As the chancre develops the anatomically related lymph-nodes show a gradual and painless enlargement. In initial lesions occurring within the mouth, this glandular enlargement is often the first symptom of the disease which attracts attention.

Secondary Period.—After development of the chancre and enlargement of the neighboring lymph-nodes, there is a second period of incubation, during which no further manifestations of the disease appear. The length of this period varies from two weeks to six months, the average being about four or five weeks. At the end of this period the so-called secondary symptoms appear. These are a general feeling of malaise, fever, headache, and pains in the long bones, especially those of the lower leg. The pharynx is congested and sore; there appears a faint generalized eruption, more marked on the chest and abdomen, which may be simply a slight hyperæmia of the skin, or it may take the form of irregular macules without elevation or induration—*syphilitic roseola* or *macular syphilide.* With this there is a painless enlargement of the lymph-nodes throughout the entire body. These are appreciated best in the cervical region, both the anterior and posterior chains, in the epitrochlear regions, in the axillæ and groins. As the initial eruption fades other cutaneous lesions appear, generally in the form of papules—*papular syphilide.* These, as a rule, are small elevated nodules of a brownish-red or copper color, and are distinctly indurated. They appear first on the abdomen, chest, and back; later on the arms and thighs; at a still later period on the forearms, face, and legs; and, finally, on the palms and soles. With these early secondary cutaneous lesions there is often an increase in the headache and malaise; the mucous membrane of the mouth and pharynx presents superficial ulcerative lesions or *mucous patches,* which are most frequently located on the lips and cheeks, near the angles of the mouth, on the sides of the tongue, on the tonsils and pharynx. There is an increased flow of saliva, the mouth is sore, and swallowing may be painful. Scabs appear on the scalp, the hair falls out, the eyebrows and beard may become markedly thin, and in places complete alopecia may be present. These symptoms persist for a variable period in untreated cases, but they may disappear spontaneously in a short time. In certain cases the symptoms are so mild as to be overlooked. At a later period recurrent eruptions appear on the skin, generally less symmetric, and often limited to small areas. These may be *papular* (large and small), *pustular*, *squamous*, or *pustulocrustace-*

ous. In certain moist localities, as about the anus, in the axillæ, or beneath a pendulous breast, large flat raw lesions may appear, which furnish an acrid secretion. These are spoken of as *condylomata* or *mucous tubercles.* Papillomata, or warty growths, may also appear in these situations, but are not to be regarded as truly syphilitic lesions, as they occur under other conditions.

If the patient has been under intelligent treatment during the first two years after his inoculation, the symptoms of the disease gradually disappear, and he may be completely restored to health.

Tertiary Period.—In a fair number of cases, however, chiefly those who have not been subjected to continuous mercurial treatment for two years, lesions appear later in life which are called *gummata.* These consist of masses of round and epitheloid cells, often forming large tumors which present a gray or yellowish color, are poorly nourished, and are prone to break down and present caseous or necrotic changes. These lesions may occur in any organ or tissue of the body and give rise to a variety of symptoms. When they occur in the skin they present lesions spoken of as *tubercular, pustulocrustaceous, rupial, ulcerative,* and *serpiginous* syphilides. In the subcutaneous tissues they give rise to *gummatous ulcerations.* On the mucous membranes, especially that of the pharynx, gummata grow rapidly and painlessly, ulcerate, and cause great losses of tissue in a comparatively short period of time.

The syphilitic virus also produces marked changes in the blood-vessels, which are observed chiefly in the smaller arteries, and result in a slowly progressive narrowing of their lumen, *syphilitic endarteritis.* This, by diminishing the blood-supply to a part, results in various degenerative changes, which occur most frequently in the tertiary period of the disease, and give rise to a variety of lesions, chief among which may be mentioned aneurism, cerebral hemorrhage, thrombosis, chronic interstitial changes in certain organs, and interference with the blood-making function. Locomotor ataxia, paresis, and other disturbances of the central nervous system are regarded by most authorities as late effects of the syphilitic poison, and are spoken of as *parasyphilitic* affections. The tertiary syphilitic manifestations in the different organs of the body will be described later.

Diagnosis.—The diagnosis of syphilis, in the great majority of instances, is easily made from the history and the results of a careful physical examination. In certain rare instances great difficulty may be encountered. In these cases the demonstration of the spirochæte in the lesions is of great value. The Wassermann or

Bauer blood reaction, at present on trial, gives promise of material help in difficult cases.[1]

Treatment.—Until the diagnosis is established, no treatment other than that addressed to the initial lesion should be given. The habit of giving mercury in doubtful cases to prevent the possible appearance of cutaneous and other lesions is to be condemned, as it may prevent the possibility of ever arriving at a correct diagnosis, and renders the life of the individual miserable from doubt and syphilophobia.

In the early or secondary stage of the disease the chief reliance must be placed on the judicious administration of mercury. This may be accomplished by the internal, the external, or by the subcutaneous use of the drug.

Internally the protiodide of mercury, preferably combined with iron to combat the always present syphilitic anæmia, is the most useful form of drug. At first from 1 to 2 grains of the drug should be administered daily in divided doses, taken immediately after meals. As soon as the effects of the drug are noticeable, the dose should be diminished and kept at a point where the symptoms are controlled without producing salivation, diarrhœa, or other unpleasant effects. The amount of mercury necessary to control the symptoms of the disease is exceedingly variable. Some patients will keep free from symptoms by ½ grain daily, while others require from 2 to 3 grains. When the dose is finally adjusted to the needs of the patient, it should be continued for two years. After this the treatment should be taken every second month for six months, after which a period of observation for six months should be insisted upon without treatment, at the end of which, if the patient has remained free from all symptoms of the disease, he may be pronounced well. On account of the ease of administration of mercury in this form, this will probably remain the most popular method of treatment for syphilis, in spite of the fact that the methods of inunction and injection are less liable to disturb digestion. Mercury may also be administered by the inunction of mercurial ointment (30–60 grains once daily), by the vapor bath, or by means of hypodermic injections. If the inunction method be employed, the ointment should be rubbed in the non-hairy portion of the skin, and a new location should be chosen each day until all of the available skin has been covered. The inunction method is considered by many more efficacious than the method of ingestion, but is less popular on account of the disagreeable features attending its application.

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[1] For a description of these reactions and the technic of performing them, the reader is referred to a recent paper by Dr. Howard Fox, *Med. Record,* March 13, 1909.

Hypodermic or intramuscular injection, while at all times slightly painful, is one of the surest, swiftest, and safest methods of treatment of syphilis. The salt of mercury most generally employed in this way is the salicylate, which is used in the following form:

Salicylate of mercury	3	(gr. xlviij);
Alboline or oil of vaseline	30	(℥j).

Inject 5 to 10 cgm. (9 to 16 minims) once or twice a week.

Fournier expresses a preference for "gray oil" of the following composition:

Purified mercury	20 parts;
Vaseline	10 parts;
Oil of vaseline	20 parts.

Dose.—Three drops at first, the dosage being increased up to seven, eight, or ten drops once a week.

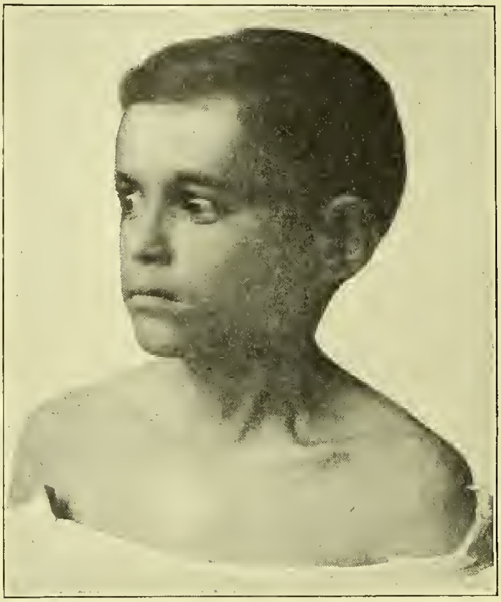
For the tertiary gummatous lesions the treatment should be mercury and potassium iodide, the former to combat any virus which may still remain in the body, the latter to promote absorption of the gummatous material. These drugs may be given in combination by the "mixed treatment" or separately, mercury being given until the constitutional effects of the drug are beginning to be manifest, followed by potassium iodide in doses ranging from 5 to 100 grains three times a day. Treatment has no effect on the vascular lesions of the disease or the degenerative changes which result from them.

Hereditary Syphilis.—A child may inherit syphilis from the father alone, which is rare; or from the mother alone, which is common; or from both parents. Formerly it was held by most authorities that the mother of a syphilitic child was always syphilitic. If this is not strictly true, it is generally recognized that such mothers are immune to the disease, as evidenced by the fact spoken of as Colles' law, that a nursing mother never acquires a nipple chancre from her syphilitic offspring.

Pregnancy occurring in a woman during the early secondary stage of an untreated syphilis generally results in abortion. If the woman is well under the influence of mercurial treatment, or if conception occurs at a later period, premature birth of a dead fœtus is to be expected. If the virulence of her infection is reduced still further by treatment or time, a living child will be born presenting unmistakable signs of congenital syphilis. If the virus is attenuated still further, an apparently healthy child may be born, which may later in life present the evidences of a syphilitic inheritance, or the child may be free from disease. It is exceedingly rare for a syphilitic child to be born of a syphilitic mother who has been under mercurial treatment for two or more years, or of a mother four years after the date of her inoculation with or without treatment. Parents frequently beget healthy children while they still present on their bodies the evidences of tertiary syphilis. It is exceedingly doubtful if a syphilitic father can transmit syphilis to his child through a healthy mother.

Symptoms.—With the exception of the initial lesion, all of the symptoms of acquired syphilis may occur in the congenital form of the disease. Syphilitic children are generally premature, are small, puny, and often deformed. The face is pinched and the skin wrinkled, given the appearance spoken of as the "old-man countenance." A macular eruption is frequently present at birth over the trunk, and mucous patches frequently are found about the mouth and anus. The child is irritable, suffers from snuffles and digestive disturbances, and rarely thrives. Visceral lesions may develop, generally gummatous in character, and early death is the rule.

Fig. 6.



Craniotabes of syphilitic origin.

If the infection is less virulent, the appearance of the child at birth may be normal; digestive and nutritive disturbances, however, occur; and as the child grows, symptoms of rickets, bone, and joint disease develop, with keratitis, cutaneous lesions, and glandular enlargements. The two upper central incisors of the permanent teeth are often notched and narrowed (Hutchinson teeth), and other deformities of the bony skeleton may be present, as a thinning of the bones of the skull (*craniotabes*) (Fig. 6) and enlargement of the epiphyses (*syphilitic osteochondritis*).

Treatment.—Congenital syphilis is treated best by the application of mercurial ointment, half strength, or of the oleate of mercury, 5 per cent., to the body of the child by means of a flannel bandage, which should be worn each night. Good food, tonics, iron, and cod-liver oil are useful at a later period.

Actinomycosis.

Actinomycosis is a chronic, infectious disease, common to man and many of the domestic animals, caused by *Streptothrix actinomyces*, or ray fungus.

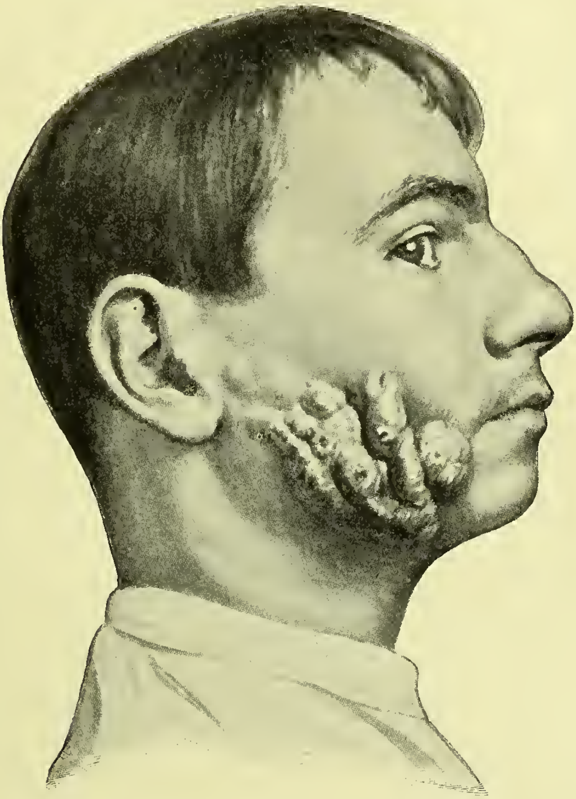
Etiology.—Actinomycosis is a widespread infection among cattle, in which it is known chiefly as "lumpy jaw." The organism probably belongs to the streptothrix group of bacteria. In the infected tissue, the contents of abscess-cavities, and the discharge from fistulous tracts the actinomyces may be found in the form of small yellowish, more or less opaque granules, varying in size from 0.15 to 0.75 mm., although larger granules often are seen. In their earliest stage the granules are usually grayish white and are easily broken up, the consistency being that of a soft jelly. As the granule grows older, it becomes more opaque and yellow, and finally it may become impregnated with calcium salts. In the earlier stages the granules are made up of fine threads, which later become thicker, and at their ends present bulbous swellings. Gradually the threads become more compact and intricate in their arrangement, and the bulbous swellings become arranged radially about the periphery of the granule. The mycelium usually appears as a bacillus from 3 to 6 μ in length, arranged in threads having many branches. The actinomyces stain readily with the ordinary basic anilin dyes. They are not decolorized by Gram's method. The bulbous swellings, on the other hand, stain only with acid dyes. The organism is a facultative anaërobe and grows upon most of the artificial media. The most favorable temperature for its growth is from 33° to 37° C. It is conceded that spore-formation occurs, the spores being much more resistant to injurious agents than is the mycelium. The actinomyces do not appear to manufacture any active toxin. Attempts at artificial production of the disease have not been satisfactory. The great carriers of the actinomycotic excitant are the different forms of cereal, especially barley, and it is mainly through their agency that man and the domestic animals become infected. Men are infected more frequently than women. Of 357 cases of human actinomycosis collected by Hutyra, one-third occurred in the third decade. Four chief avenues of infection have been distinguished: First, through the mouth and pharnyx; second, through the respiratory tract; third, through the gastro-intestinal tract; fourth, through the skin, wounds, etc. In a certain number of cases no portal of entry can be made out.

Pathologic Anatomy.—The lesions at the outset may be insignificant. Microscopic examination of an actinomycotic focus shows a central portion containing the fungus, usually free or attached to the foreign body by means of which it gained access to the part. In addition there are more or less débris and products of degeneration. Around this portion is a zone of small, round, and epithelioid cells. The outermost portions of the actinomycotic focus are characterized by more or less extensive round-cell infiltration. Giant cells are sometimes present. The proliferation of cells may become so extensive that a definite tumor-like mass is produced. Suppuration sometimes occurs. The tendency to the formation of fistulous tracts is characteristic, the discharge from these fistulæ sometimes being serous, sometimes purulent. The discharged material usually contains the actinomycotic granules. The lesions extend rather by continuity than by metastases. Poncet and Berard proposed the following division of actinomycotic infections: First, cervicofacial; second, thoracic; third, abdominal; fourth, cutaneous. Foci in the spinal column, genito-urinary tract, brain, special organs of sense, etc., are regarded as complications. Statistics show that about 55 per cent. of the cases belong to the first group; about 20 per cent. to the thoracic and pulmonary group; and about 20 per cent. to the abdominal type; 5 per cent. covering the remaining forms.

Symptoms.—Actinomycosis, with rare exceptions, is a chronic disease, lasting for months or years. Four clinical forms are described:

Face and Neck.—The initial lesion often begins around a carious tooth. The patient comes under observation with a swelling of one side of the face or with an enlargement of the jaw, which may simulate sarcoma (Fig. 7). The lesion is seen best on the outer side of the jaw in the form of a swelling, with one or more fistulous tracts discharging material which often contains the characteristic sulphur-like granules. In the chronic forms pain is not frequently complained of, except, perhaps, on pressure. Fever is generally absent and the general health remains good. If not checked, the process may extend to the neck, along the pharynx, and finally involve the vertebræ or the thoracic organs (Fig. 8). Amyloid degeneration of the viscera is sometimes seen. In the acute forms fever is present and the symptoms are those of phlegmon. The tongue is rarely involved.

FIG. 7.



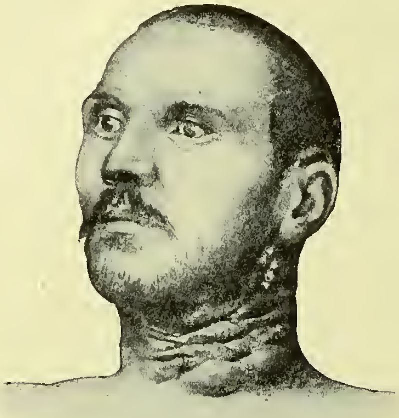
Actinomycosis of the cheek. (Illich.)

Thorax.—Involvement of the thoracic organs is generally secondary to lesions on the face and neck, but the lungs may be the primary seat of the infection. In this form we have a chronic infectious disease of the lungs—cough, fever, emaciation, and mucopurulent discharge. Hodenpyl recognizes three types: First, lesions of chronic bronchitis; second, miliary actinomyces, the lesions of which closely resemble those of miliary tuberculosis; third, cases in which we have bronchopneumonia, interstitial changes, and abscess formation. Clinically the disease resembles certain forms of pulmonary tuberculosis. The diagnosis is made by finding the actinomyces.

Abdominal Organs.—In this form the gastro-intestinal tract is primarily involved. There is no organism which may cause so extensive destruction of the abdominal viscera as actinomyces. Adhesions and abscesses are conspicuous features of the lesions.

The antinomyces gain access to the stomach with food, either animal or vegetable, most commonly the latter. Neither the gastric juice nor the bile appears to have any very decidedly harmful effect upon the fungus. Once having penetrated the mucosa, two modes of progression are possible : first, a superficial involvement of the mucosa ; second, a penetration into the deeper structures without leaving behind any demonstrable defect in the mucosa.

FIG. 8.



Actinomycosis of the neck. (Lexer.)

Intestinal actinomycosis usually appears first as a small nodule in the submucosa, which undergoes degeneration at its centre and presently gives rise to a small ulcer. In certain instances the ulcers heal, leaving irregular pigmented scars.

Among the secondary lesions of abdominal actinomycosis those of the liver are the most frequent. From 50 to 60 per cent. of the abdominal cases originate in the cæcum and appendix ; less frequently the disease starts in the rectum, stomach, or small intestine.

In many cases the onset is quite sudden—catarrhal disturbance of the intestine, diarrhœa, vomiting, or constipation. In other cases the symptoms simulate those of recurring appendicitis. The initial symptoms may last for weeks or months. The second period of the disease is characterized by tumor formation, which is generally in the right iliac or umbilical region. The tumor outline is usually indefinite and irregular. Pain is common. Later, softening of the infiltrated portions takes place, leading to fistulous formation, and the surrounding skin assumes a bluish-violet tint, which changes to a slate color from center toward the periphery. According to some observers this appearance is sufficiently characteristic to excite suspicion of actinomycosis. Spontaneous recovery is possible. The prognosis is variable ; it is the best in those cases which are amenable to surgical treatment, and it is for this reason that the prognosis is more favorable in abdominal than in thoracic cases.

Skin and Brain.—Actinomycosis of these tissues is rare. In the skin the lesion stimulates tuberculosis. The cerebral lesions are generally post-mortem findings.

Treatment.—This is largely surgical. If the foci of infection can be completely removed, recovery may be expected. In the majority of instances this is not possible, and partial removal with the administration of large doses of potassium iodide, or the salts of copper, constitutes the best treatment. The various forms of radiant energy may be employed.

Blastomycosis.

Blastomycosis (Oidiomycosis) is a localized inflammation, papular or pustular in character, affecting the skin (blastomycetic dermatitis), which is caused by the parasite yeast organisms, *Blastomycetes* or *Oidii.* These occur as rounded, double-contoured bodies measuring 10 to 20 μ in diameter, which reproduce by budding and contain various rounded refractile or granular structures. They are found in the diseased tissues and frequently within the giant cells, are readily cultivated on artificial media, and can be successfully inoculated into animals.

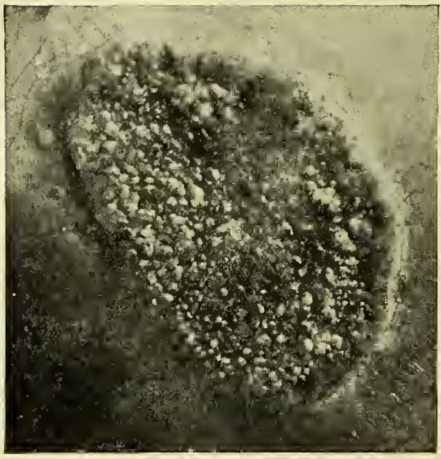
Clinically the disease may be confused with syphilis, lupus vulgaris, lupus verrucosus, or epithelioma. The diagnosis may always be made by microscopic examination of smears and tissue.

The process is found most commonly on the skin of the hands and face, particularly about the orbit. Though generally local, generalization may take place, causing involvement of the lungs, bones, muscles, spleen, or kidneys. Though the skin is usually the seat of the primary infection, the viscera may be the structures first involved.

Clinically the disease starts as a papule, developing into an ulcer, which may become quite extensive. It extends laterally by the formation of minute, dermal, and subdermal abscesses. A superficial crust covers a red granulating mass, which is verrucous, with sharp, elevated borders, and exudes a seropurulent secretion (Fig. 9).

Microscopically there is extensive tissue hyperplasia, containing giant cells, small abscesses, detritus, and the organisms. The surrounding tissue shows chronic inflammatory changes with the presence of giant and mast cells.

FIG. 9.



Cutaneous blastomycosis. (Hyde.)

When limited to the skin this disease, though of an obstinate nature, is not fatal.

Systemic infection, however, generally results in death.

Treatment.—Treatment consists of curetting or, preferably, complete extirpation, followed by antiseptic solutions.

Improvement and cure have occasionally been obtained by the internal administration of large doses of potassium or sodium iodide and the local application of antiparasitic solutions. Bevan has advocated copper sulphate in dosage of $\frac{1}{4}$ grain t. i. d., increasing it to $\frac{1}{2}$ grain t. i. d., and externally a 1 per cent. copper sulphate wash.

CHAPTER V.

TUMORS.

THE word *tumor* is often used by the clinician in a general and indefinite way to designate any abnormal swelling of circumscribed extent, without reference to the cause or precise character of the lesion. Etymology justifies this use; but custom has narrowed its application. It is therefore proper to restrict the meaning of the term, so that by its use we may denote any circumscribed new growth of tissue, derived from some preëxisting normal body tissue by proliferation of the constituent cells, which shows greater or less departure from the typical structure and functions of the parent tissue, which serves no useful purpose, and which generally is not restrained within definite growth limits. Tumors are then independent, or as Thoma characterizes them, "autonomous" new growths. They may arise in any tissue the cells of which are capable of reproduction and the smaller bloodvessels of which are competent to nourish the newly developing structure. The process of cell division and of development of new bloodvessels are in general similar to those of normal tissue growth, regeneration, and repair. The finer details of nuclear division by karyomitosis are, however, frequently atypical, and the cellular growth often shows an exuberant development well expressed by the word "lawless." The cells composing tumor growths are largely subject to heredity, and hence the histology of a given tumor usually enables us to determine its tissue paternity.

Etiology.—The etiology of tumors is a very complex and difficult subject, which can be only briefly touched upon here in its more important aspects.

Having a bearing upon the occurrence of tumors, the following are distinctly recognized:

Age.—Though tumors are most frequent in adult and advanced life, there is a tendency for those of the connective-tissue type to occur somewhat earlier than those of the epithelial type.

Sex.—While, in general, malignant tumors are about twice as frequent in females as in males, malignant tumors of the stomach, tongue, and lips are more common in males. On the other hand, tumors of the breasts and reproductive organs are far more common in females.

Race.—While *carcinoma* is common in the white race—especially in the female breast and uterus, it is a striking fact that this form of tumor is exceedingly rare in the negro race—where tumor formation in these organs is far more frequent in the form of fibromata.

Local Predisposing Factors in the Development of Tumors.—Though the part played by local injuries in the formation of tumors is a matter not clearly understood, it has frequently been observed that while bruises or contusions—especially those involving the bones—are sometimes followed by the formation of malignant tumors of connective-tissue type—*sarcoma, osteosarcoma,* etc.—repeated injury or long-continued irritation is more liable to be followed by the formation of malignant tumors of the *epithelial* type. Such an observation is especially applicable in connection with tumors of the *sphincters* of the body and tumors of the breast and stomach following prolonged inflammation.

While Volkmann's theory of the influence of trauma undoubtedly represents one of the factors active in the production of malignant tumors, more stress has recently been placed on Cohnheim's theory advocating the occurrence of tumors as the result of the growth of superfluous or displaced embryonal cells. Ribbert, recognizing the importance of both of these theories, considers another factor essential, viz., the separation of cells from their normal relationships by embryonal or post-fœtal developmental processes, by trauma or inflammatory processes; the dissociated cells growing independently and in limitless fashion, because the organism has lost control over them.

The theories advocating bacteria and other parasites as a cause have never received very strong support, though many observers have been impressed with the occurrence in some tumors of *protozoa-like* bodies. The striking analogy which exists between the clinical course of cancer and some of the chronic infectious diseases renders this theory at least reasonable. The theory of the communicability of cancer, still to be proved, finds some of its strongest advocates among the supporters of this origin of cancer.

While the communicability of cancer has never been proved in man, some of the most interesting and important of the modern research work on cancer has shown that it is possible to transplant pieces of cancer tissue from one animal to another of the same species and continue this process through many generations of tumor growth.

Ehrlich has even secured active immunity against cancer in mice by injection of the living cells of slightly virulent strains of mouse carcinoma.

Innocence and Malignancy in Tumors.—There is no sharp dividing line between innocence and malignancy in tumors, for while such tumors as fibromata are always clearly benign, and small round-celled sarcomata always clearly malignant, there are tumors belonging to the same connective-tissue type group which occupy an intermediate position. Such, for example, are some endotheliomata, gliomata, and giant cell sarcomata. Furthermore, there is some evidence that a benign adenoma, when existing in such an organ as the female breast, may be excited to malignancy through the agency of a concurrent inflammatory process; and that special potentialities of malignancy may exist in some benign tumors merely in relation to their anatomic location is evidenced by the frequency with which some papillomata of the larynx, and urinary bladder, and adenomata of the uterus and large intestine assume malignant characters.

Malignancy, then, being a relative term, and its signs developing irregularly with the growth of the tumor, reliance for its diagnosis must be placed, not upon one attribute of the tumor, but upon several, taken in conjunction with each other.[1]

Such attributes are as follows:

Gross or Clinical:

Rapidity of growth.
Invasion of adjacent tissues by eccentric or peripheral growth, or infiltration.
The tendency to local recurrence after removal.
The formation of metastases.
The tendency to produce cachexia.

Microscopical:

Abundance of *mitoses*, especially of abnormal types.
Evidences of "lawlessness" and variation in size of cells, and degree of departure from normal types.
Poor structure of bloodvessel walls and tendency to hemorrhage.
Relatively larger size of nucleus.
Tendency to degeneration.

While it is an obvious corollary that conditions opposite to those stated in the previous list point to innocence in tumors, there are a few exceptions which it is well to bear in mind. For example, while degeneration is most common in tissues whose rapidity of growth outruns its blood supply, and in tissues which are so lawless and unstable as to have little vital resistance, nevertheless it is not uncommon to find many types of degeneration in even the most benign tumors. Such, for example, are *hyaline*, *amyloid*, *fatty*, *albuminous*, *calcareous*, or *mucoid* degenerations.

Furthermore, while most benign tumors are circumscribed, some, such as a few lipomata, may be diffuse; even benign tumors may recur if not completely removed; and some benign tumors—angiomata—may be largely composed of bloodvessels, many of which have poorly formed walls, with some tendency to hemorrhage.

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[1] According to the conception of malignancy here used, this term would not apply to the effect of pressure of a tumor on a neighboring vital organ or interference with its function through pressure or displacement.

Treatment.—The treatment, in general, of all operable tumors, is essentially surgical, the character of the operation being dependent upon the character and location of the tumor. (See chapters on Special and Regional Surgery.) While a few non-operative procedures for the treatment of tumors—of which the use of caustics, the various forms of radiant energy, and Coley's serum are examples—are known, these methods have their most frequent applicability in instances where consent for operation cannot be obtained or instances of inoperable malignant tumors.

While there are occasional exceptions in the treatment of some cysts, the cardinal rule of procedure in the case of all operable tumors is removal in their entirety, as even the most benign tumors will return if only partially removed, and innocent cysts will often be re-formed if a portion of the cyst wall be allowed to remain.

Classification.—The pathologic classification of tumors is most conveniently based upon their anatomic structure. They may be divided into the following groups:

Connective-tissue Type:

Fibroma,
Lipoma,
Myxoma,
Chondroma,
Osteoma,
Myeloma,
Sarcoma,
Endothelioma,
Glioma,
Angioma { Hæmangioma,
Lymphangioma,
Myoma { Leiomyoma,
Rhabdomyoma,
Neuroma.

Epithelial-tissue Type:

Papilloma,
Adenoma,
Carcinoma,
Epithelioma.

Mixed Type:

Teratoma.

Special Tumor Types:

Chorion-epithelioma or deciduoma,
Hypernephroma,
Psammoma.

SPECIAL VARIETIES OF TUMORS.

Fibroma.

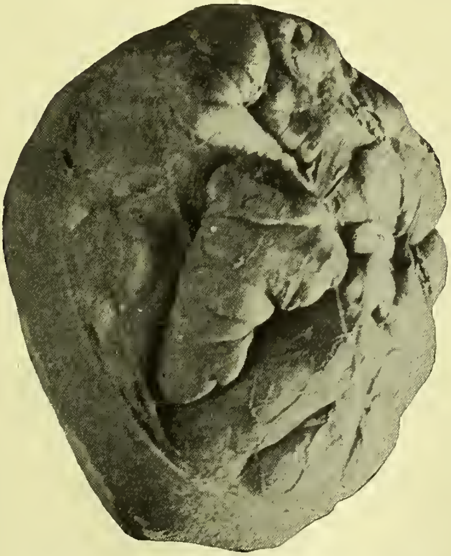
The gross and microscopic features of fibroma resemble those of connective tissue. They may be hard, *fibroma durum*, or they may by soft, *fibroma molle*. Generally they are circumscribed masses, frequently encapsulated. They vary in shape, sometimes growing as papillomatous masses, or as polypi seen in the the nose, or they may be diffuse. Many of these growths, especially the firmer ones, present a white surface in which the fibrous strands may be seen interlacing in various directions. Fibromata may occur anywhere in the body, but are found especially in the skin, periosteum, fascia, uterus, and mammary gland. The firm fibromata are usually oval or globular, smooth, movable, very hard, generally single, and painless unless attached to a nerve. The softer forms are smooth, globular, elastic, soft, and painless. Tumors of this class are usually of slow growth, and do not give rise to true metastasis.

Microscopically, fibromata consist of connective tissue showing variable proportions of cellular elements. The hard varieties show few cells and bloodvessels; the softer ones, on the contrary, are more cellular, and generally have a richer blood supply. They often contain elastic tissue. Mucoid, myxomatous, and fatty changes are common. Keloid is a form of fibroma which develops in scar tissue after injury or operation.

Lipoma.

The structure of tumors of this class is like that of ordinary adipose tissue. They are often found in the subcutaneous tissue about the neck, shoulders, axillæ, and groins. Less frequently

Fig. 10.



Lipoma, showing characteristic lobular appearance.

they are found in the kidneys, intestine, and other viscera. They are of slow growth, and sometimes follow injury. They are benign, but occasionally cause disturbances by pressure. They form circumscribed and encapsulated, lobulated, semi-fluctuating, painless, soft elastic tumors, generally single, but occasionally multiple, and grow slowly. A diffuse form is known, occurring most frequently in the neck. A dimpling of the skin is often evident when these tumors are pinched up between the thumb and finger (Fig. 10).

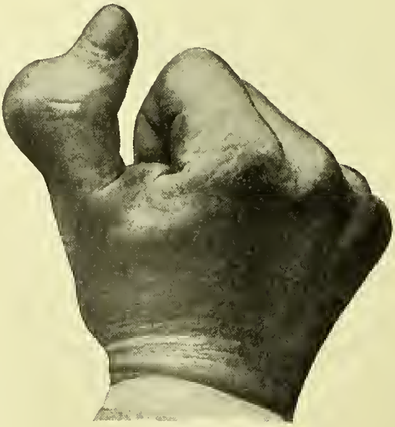
Myxoma.

Tumors of this class are closely related to the fibromata. A pure myxoma is unknown. Myxomata are rather soft, gelatinous tumors, of various shapes and size. The outlines are well defined; and when growing from mucous membranes they form polypi. They consist of stellate and spindle-shaped connective-tissue cells; and the tissue spaces are filled with a substance resembling mucin. Their appearance is like that of certain edematous fibromata. Myxomata have been found in the skin, breast, brain, and spinal cord. Most of the soft nasal polypi belong to this class. As with fibromata, growth is usually slow.

Chondroma.

This group includes tumors made up of hyaline or fibrocartilage.

Fig. 11.



Chondroma.

On section they have a cartilaginous appearance and are often encapsulated. Areas of ossification or mucoid degeneration are common. They may arise from tissues which normally contain cartilage, but they are often found where none normally exists, as in the testicles, bone, parotid glands, mammæ, etc. Multiple chondromata are occasionally seen on the hands and feet. Growth is slow and they are benign. Very rarely metastasis occurs. Mixed forms of cartilaginous tumors are common; most of those in the parotid and testicles belong to this class (Fig. 11).

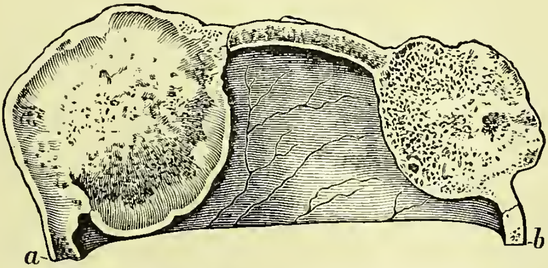
Osteoma.

An osteoma is a new growth composed of bony tissue. Two varieties are recognized: the spongy or cancellous and the compact. The spongy osteoma is most frequently found at the ends of the long bones of the limbs, or growing from the cranium (Fig. 12). It grows very slowly, and rarely causes any discomfort unless it presses upon a nerve trunk or important organ.

The compact osteoma usually grows from the bones of the skull. It is generally sessile and solitary, and may grow into the interior of the skull, into the frontal sinus, or into the cavity of the orbit or nose.

Exostoses are bony tumors growing upon the surface of bones. These formations sometimes occur in muscles and tendons, especially at their points of attachment to the skeleton.

FIG. 12.



Cancellous osteomas springing from the diploë. (Musée Dupuytren.)

The name *odontoma* is applied to an osseous growth in connection with teeth.

Myeloma.

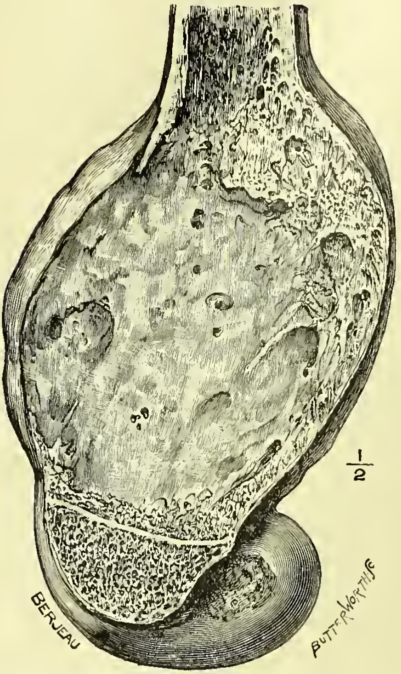
Occupying a position intermediary between the osteomata and osteosarcomata are those bone tumors known as myelomata, which are considered by Bland-Sutton to form a class distinct from both.

They are composed of tissue resembling the red marrow of bone and differ from sarcomata in not being malignant. They occur most frequently in the cancellous tissues at the ends of the long bones. The cut surface of the tumor usually presents a deep red or maroon color. The tumor grows slowly, expands the bone, and thins the osseous capsule while expanding it until the bony shell is so thin that it crepitates when pressed by the finger (Fig. 13).

Microscopically myelomata abound in large multinuclear cells (giant cells) imbedded in round or spindle cells. If the giant cells do not greatly predominate, but occur with round or spindle cells in nearly equal proportions, the tumor becomes more nearly allied to the mixed-cell sarcomata.

To the myeloid type of tumor, abounding in giant cells, which occurs in connection with the gums, the name *epulis* is applied. The growth of these tumors is slow.

Fig. 13.



Lower end of the femur in section to show a myeloma. From a girl seventeen years: she was known to be alive and well five years after amputation through the middle of the thigh.

Sarcoma.

Tumors of this class are malignant in nature and are composed of miniature mesoblastic or embryonic connective tissue, in which cells predominate over intercellular stroma. They present divers characters structurally and clinically, but have the following in common:

Each cell is surrounded by a varied amount of intercellular substance which has no definite arrangement; the bloodvessels have very thin walls, and are often merely spaces bounded by the cells themselves, hence, the frequency with which hemorrhages occur. Dissemination usually takes place by the bloodvessels. Sarcomata occur most frequently in youth and early middle life. Their origin may sometimes be found to be associated with trauma, and any region of the body may be involved. The most common locations are the subcutaneous areolar tissue, fascia, bones, periosteum, kidney, meninges, lungs, liver, and alimentary canal.

Sarcomata are classified most conveniently according to the prevailing types of cell present; some species being subdivided into two or more varieties and some consisting of mixed forms.

Round-cell Sarcoma.—This group consists of the small and large round-cell sarcomata, as well as that known as lymphosarcoma and gliosarcoma. They are among the most malignant of all tumors. Their consistency is usually soft, they are vascular, and often grow to a large size with a great tendency to disseminate. (Plate III.)

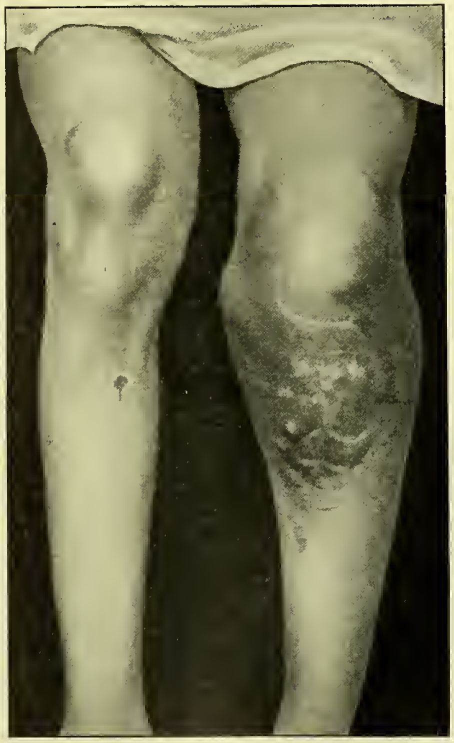
The small-celled variety consist of small round cells with very little cytoplasm and intercellular stroma; so little in fact as to be difficult to demonstrate. The bloodvessels are thin-walled channels occurring between the cells of the tumor (Fig. 14).

In the large round-cell variety the cells are larger but variable in size, the nuclei are large and contain prominent nucleoli, the cytoplasm and intercellular substance are more abundant, and the tumor is somewhat firmer than the small round-cell tumor.

Lymphosarcomata are excessively malignant, arise from lymphoid tissue, and consist of small round cells resembling lymphoid cells contained in a delicate reticulum.

Gliosarcomata occur most frequently in the brain and retina, and have a matrix like that of the neuroglia of nerve centres.

Fig. 14.



Sarcoma of bone.

Spindle-cell Sarcoma.—This group, consisting of the small and large spindle-cell sarcomata, is of common occurrence. They frequently are found in the periosteum, subcutaneous tissue, muscle, uterus, and secreting glands. On section they have a pinkish-white color, the large cell type being soft and rapid growing, while the small cell type is slower in growth and moderately firm. In both the cells are spindle shaped, often arranged in fascicles which surround the bloodvessels, with very little intercellular substance. In the large spindle form the cells frequently contain several nuclei.

Closely allied to these two groups in the morphology of the cells are the *melanosarcomata*, which may be composed of round, spindle, or polyhedral cells. They arise most frequently in the choroid and in the skin, especially from pigmented moles. They receive their name from the fact that particles of brown or black pigment occur in the cells or intercellular substance. These tumors are very malignant, and have a marked tendency to form metastases, which are also pigmented.

Giant-celled Sarcoma.—Giant-celled sarcomata are tumors closely resembling the myelomata (already described), but containing spheroidal or fusiform cells in excess of giant cells, and having well-marked malignancy. Some originate in the marrow, are soft and very vascular, and prone to form metastases. Others originate in the periosteum, are firmer, and grow up by a new formation of bone tissue as an osteosarcoma.

In the mixed forms of sarcoma the types of cells already described are found associated with a new growth of bone (osteosarcoma), bloodvessels (angiosarcoma), glands (adenosarcoma), connective tissue, cartilage, etc.

Endothelioma.

Neoplasms which spring from the endothelium of blood- and lymph-vessels or of lymph-spaces or clefts of connective tissues, and the great serous cavities, are classed in this group. They have long been confused with the carcinomata, chiefly on account of the morphologic resemblance of epithelium and endothelium. In the endotheliomata of blood- and lymph-vessel origin it is often possible to trace the growth from the endothelial cells, but when the growth departs from the vessels there is a tendency to alveolar arrangement which frequently suggests carcinoma. The amount of stroma may be great or small, and can frequently be shown to be intercellular. These tumors may show various forms of degeneration, especially those of the parotid, testicle, and dura, which may contain calcareous and laminated depositions. These last are called *psammomata* or brain-sand tumors.

Endotheliomata vary in form and rapidity of growth, those of the adenomatous type being comparatively benign, while some resembling the sarcomata and carcinomata may be very malignant.

Glioma.

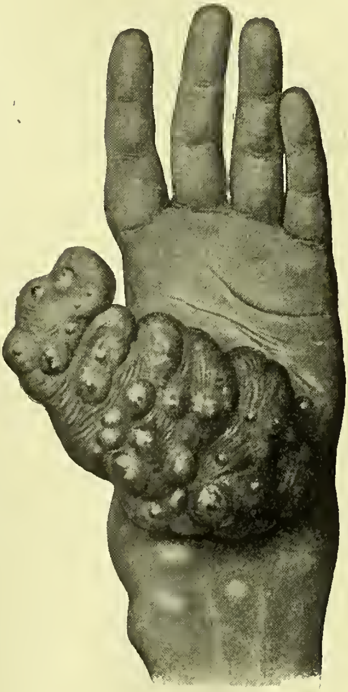
Under this heading are grouped certain tumors which originate either from the neuroglia of the brain and cord or from the cells lining their cavities. It is only rarely that they take their origin in the retina. They do not often gain great size and may be either hard or soft. In color they resemble that of the tissue in which they are found. Histologic studies show that they are composed of neuroglia tissue often associated with true nerve tissue, such as ganglion cells and nerve fibres. Evidences of old and recent hemorrhage are common. Growth may be slow or rapid, involving the brain and cord, but not their membranes. Gliomata of the retina are generally malignant.

Angioma.

Tumors chiefly composed of vascular elements are grouped under this heading; those of bloodvessel origin, as *hæmangioma,* and those of lymph-vessel source, as *lymphangioma.*

Several varieties of hæmangioma are recognized. In the case of the "port-wine" skin discolorations, birth-marks, or *nævi* it is doubtful whether there is any formation of new bloodvessels or not; some believe that the growth is due to dilatation or hypertrophy of bloodvessels originally present. There is another variety of angioma which consists of communicating blood-spaces bounded by endothelium and connective-tissue walls. These are known as *cavernous angiomata* (Fig. 15).

FIG. 15.



Angioma of hand.

The hæmangiomata are small or large, of a bluish, purple, or reddish color, and sometimes showing pulsations. They bleed easily. The diffuse simple angiomata, *angioma telangiectoides,* are usually found in the skin, especially in the region of the neck and head. They are mostly of congenital origin. The cavernous angiomata are, on the other hand, generally found in the liver.

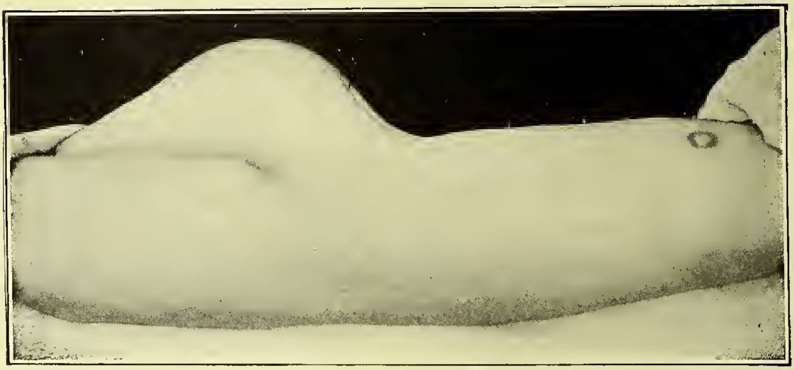
Lymphangiomata consist of growths formed either of dilated or newly developed lymph-vessels. Apart from differences as to their contents, they have essentially the same structural features as the angiomata of bloodvessel origin. Thus we have *lymphatic nævi, lymphatic telangiectasis,* and *cavernous lymphangioma.* In some instances cystic formation results, *cystic lymphangioma;* whereas those which contain chyle are termed *chylangiomata.*

Myoma.

Tumors of this group consist either of striped (*rhabdomyoma*) or unstriped (*leiomyoma*) muscle tissue.

The rhabdomyomata are rare, and have most often been found in connection with the genito-urinary tract, especially the kidneys. They appear generally in childhood, and are sometimes associated with sarcomatous tissue. The size of these growths is small. The characteristic histologic features consist in the presence of striated muscle tissue, of smaller size than normal and rather irregularly arranged.

FIG. 16.



Fibroid tumor of the uterus. Note the sharp decline of the tumor in the epigastrium. (Photograph from the Gynecologic Service of the University of Michigan Hospital.)

The leiomyomata are known best under the name "uterine fibroids" (Fig. 16). Many of them are of very large size and they may be single or multiple. They are usually firm, nodular, and of whitish or pinkish color. A variable amount of fibrous tissue is generally present in them. The uterus, especially after puberty, is their chief point of origin; less frequently they occur in the gastro-intestinal and genito-urinary tracts, in the skin, and larynx.

While uterine leiomyomata may occasion neither inconvenience nor suffering, they frequently give rise to profuse hemorrhage from the ureters, and they may cause serious symptoms by pressing injuriously on the ureters or the intestine, or by complicating pregnancy and parturition.

Microscopically leiomyomata consist of smooth spindle-shaped muscle fibres collected into bundles irregularly arranged in a connective-tissue stroma. Various degenerations are common, such as cyst formation, gangrene, and calcification. Sarcomatous metaplasia is sometimes observed.

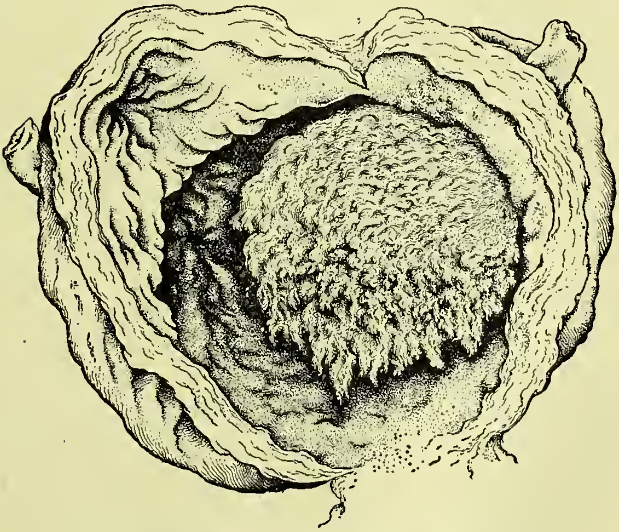
Neuroma.

In the strict sense, a neuroma is formed of proliferated nerve-elements proper, but the term has been loosely used to include all new growths containing nerve cells or nerve fibres in a fibrous matrix, such as amputation neuromata. True neuromata are rare, but tumor masses containing fibrous tissue and nerve elements are fairly common.

Papilloma.

Papillomata are tumors which project from a cutaneous or mucous surface and consist of a central axis of vascular fibrous tissue, hypertrophied papillæ, with a covering of epithelium, which resembles that of the surface from which the tumor grows. In the papillomata of the skin—commonly known as *warts*—the covering

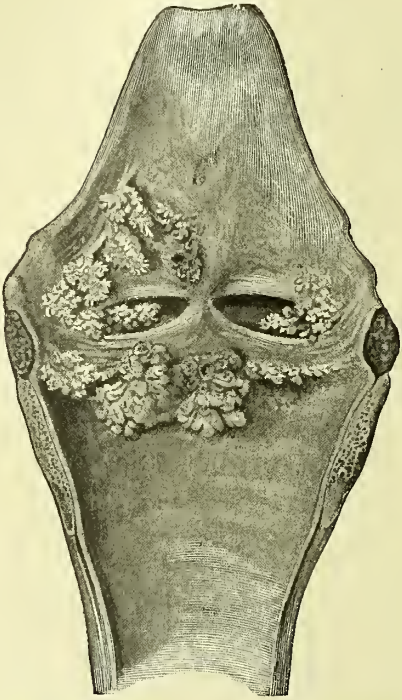
Fig. 17.



Villous tumor (papilloma) of bladder. (Musée Dupuytren.)

consists of epidermis ; in those growing from mucous membranes it consists of the surface epithelium. When the surface epithelium projects as filiform processes, the tumor is called a *villous papilloma*, the best known example of which is met with in the urinary bladder (Fig. 17). Papillomatous growths are also met with in the larynx (Fig. 18), in the ducts of the breast—the so-called *duct papilloma*—and in the interior of certain cystic tumors of the ovary. Although papillomata are innocent, when subjected to irritation they may become the starting-point of cancer. This tendency is especially well marked in the papillomata of the larynx and urinary bladder, which may develop into papillary epitheliomata ; in the duct papillomata of the breast, which may develop into duct carcinomata, and in the case of villous papillomatous growths of the ovary, which may become detached and transplanted to the surface of the peritoneum in large numbers.

Fig. 18.



Multiple papilloma of larynx. (von Bergmann.)

In old people warty growths of the skin may develop into epitheliomata.

Adenoma.

The adenomata are new growths of epithelial type, derived by proliferation of the epithelium of mucous and cutaneous glands or of the more specialized epithelium of certain gland-like organs.

The epithelial proliferation is accompanied by a strictly proportionate or even an excessive development of a vascular, connective-tissue stroma; and the resulting structure—when the tumor is of glandular origin—is composed of new-formed gland spaces, of acinous or tubular type, which are lined by a single or by several superimposed layers of epithelial cells. The epithelial growth shows no tendency to overstep the growth of its supporting stroma, and generally preserves a fairly typical glandular arrangement.

There is no invasion of neighboring tissues by peripheral infiltration and no habit of metastasis. Cystic formation is common and quite characteristic of certain adenomata, especially those of the ovary. The adenomata form a very large and variable class. On the one hand, it may be difficult to distinguish a given specimen from a mere regeneration or hyperplasia of normal gland tissue; on the other hand, it is impossible to distinguish certain adenomata from the malignant carcinomata. This is especially the case with adenomata of the intestine and uterus.

Carcinoma (Cancer).

The carcinomata are malignant tumors composed of epithelial cells arranged in the form of columns, atypical acini or alveoli whose walls are formed of connective tissue. The cells, while varying in shape and size, closely resemble in their general characters the epithelial cells of the part from which they spring, and within the aveoli are not separated from each other by stroma, thus differing from the sarcomata. In this stroma the blood-vessels and lymph-vessels ramify.

Carcinomata are divided, according to the type of cell of which they are formed, into *spheroidal*, *cylindrical*, and *squamous* forms—members of the last group being always known as *epitheliomata*, occurring in the skin and squamous-celled mucous membranes.

The spheroidal cell forms always spring from glandular structures, and are often termed carcinoma simplex.

Cylindric carcinomata may spring from any pre-existing cylindric epithelium, but are found most commonly in connection with the gastro-intestinal tract and uterus.

While the evidences of malignancy in carcinomata occur according to the general rules already laid down for malignancy in tumors, special stress is laid upon the fact, that while in the related forms of benign growth, of which papillomata of the skin and rectum may be taken as examples, the growth does not extend below the basement membrane; in the carcinomata of these situations the basement membrane is pierced by the tumor cells.

In the cuboidal form the departure from the benign adenoma type is indicated by a piling up of the rows of lining cells, which lose their direct relationship to the basement membrane and ultimately may form alveoli instead of acini, ceasing to reproduce the glandular type.

Carcinomata show the strongest tendency not only to local recurrence but also to metastasize in distant regions. Extension of the growth is partly by the direct infiltration of neighboring tissues and partly by way of the lymph-channels.

Degenerative changes are very common, occurring most commonly as fatty or myxomatous degeneration.

From the colloidal form of degeneration a type of carcinoma occurring most commonly in the stomach and peritoneum has received its name—*colloidal carcinoma.*

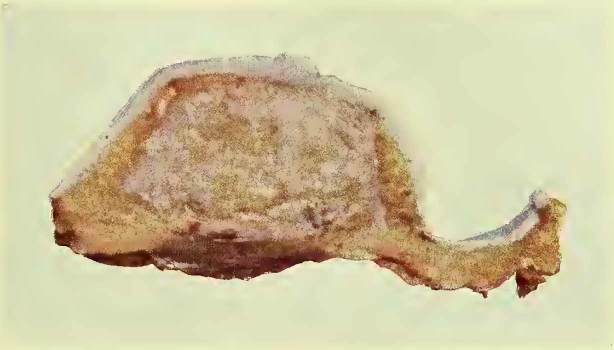
Carcinomata produce poisonous products which impair the general health of the individual, resulting in a condition known as cancerous cachexia.

The majority of carcinomata (70 per cent.) occur between the ages of forty and seventy. Under fifteen years the disease is scarcely known. Trauma and chronic irritation are important factors favoring carcinomatous development in many cases; but as to the real exciting factors we know very little. Being unable, therefore, to remove the cause, in view of the fact that carcinoma is not only one of the commonest of surgical diseases, but is apparently increasing in amount in some districts, the ability to diagnosticate the condition in its early forms becomes a matter of greatest importance, enabling the removal of the entire process before its extension has made the condition inoperable and its termination fatal.

Spheroidal-celled Carcinomata.—Spheroidal-celled carcinoma are usually subdivided, according to the relative abundance and density of the fibrous stroma, into "*scirrhous*" and "*encephaloid.*" No definite line, however, separates these groups.

Scirrhous Carcinoma.—Scirrhous carcinoma occurs as a firm, hard, nodular growth, depressed in the centre owing to contraction of the fibrous tissue. This contraction is very characteristic of scirrhus of the breast, where it causes retraction of the nipple and puckering of the skin (Fig. 19). The cut surface is of grayish-white, semitranslucent appearance, like that of an unripe pear. From the central mass stellate processes of new growth may radiate for an indefinite distance into the surrounding tissue. Microscopically scirrhous carcinoma consists of collections of sphe-

PLATE III

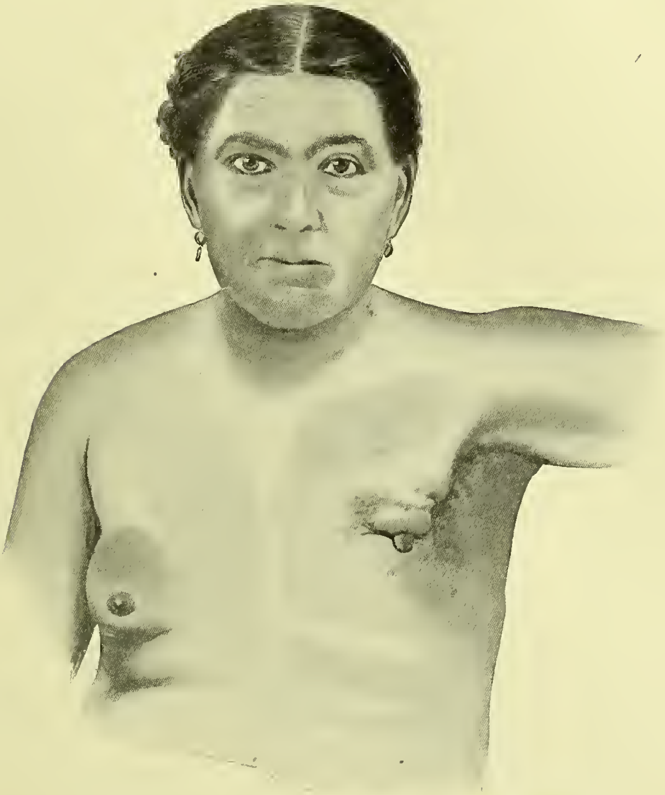


Extensive Carcinoma of Breast.

Colored photograph of a fresh specimen. (Lumiere method.)

roidal epithelial cells of various sizes surrounded by an excess of connective-tissue stroma. A single alveolus may consist of many or only two or three cells. The overlying skin may become involved, slough, and an ulcer may result, or the infiltration may become so dense as to have the consistence of cartilage forming a "*schirrhus en cuirasse.*" To that form of breast scirrhus following an eczematous inflammation of the nipple occurring beneath the inflamed area but having no direct continuity with it, the name *Paget's disease* has been given.

FIG. 19.



Atrophic scirrhous carcinoma of the breast. (von Bergmann.)

Scirrhous carcinoma is most common in women after the age of forty and is of very slow growth, although the lymph-nodes in the neighborhood may be early involved by secondary deposits.

While the female breast is by far the most common seat of scirrhous carcinoma, it is also found in the uterus, stomach, and œsophagus.

Encephaloid Carcinomata.—Encephaloid carcinomata occur most commonly in the breast, ovary, stomach, liver, and bladder as soft, elastic, rapidly growing tumors, quickly terminating in ulceration, involvement of neighboring glands, and general dissemination through the body. The stroma is scanty in amount and the spheroidal epithelial cells are contained in large alveoli. Evidences of rapid cell division, degeneration, and hemorrhage are common.

Cylindric-celled Carcinomata.—The cylindric-celled carcinomata consist of cells derived from cylindric or columnar epithelium. They occur most frequently in the stomach, intestines, and uterus, and may occur in the breast as *duct cancers.* They often begin as papillary outgrowths from the mucous membranes, especially when growing in the rectum, where they are frequent.

Microscopically, these tumors consist of more or less acinus-like tubular structures composed of several layers of epthelial cells. These acini, which are bound together by a delicate stroma, may, in the later stages, become completely filled with epithelial cells.

In these tumors there may be seen all gradations of structure between a definite adenoma and a typical carcinoma; hence the name applied to some of these intermediary forms of *malignant adenoma* or *adenocarcinoma.* These gradations are seen especially in growths from the uterine endometrium.

In these cases the extension of the growth into the muscular coats is an important indication of malignancy.

Epithelioma.

Squamous-celled carcinoma or *epithelioma* usually occurs at the junction of skin and mucous membrane, or where two kinds of epithelium come together. It is frequently found on the lower lip, nose, penis, scrotum, vulva, anus, and tongue, less commonly on the gums, palate, tonsils, larynx, pharynx, œsophagus, bladder or uterus, and general cutaneous surface; rarely on the hands and feet. It has frequently been known to follow chronic ulceration and prolonged irritation. It usually starts as a cauliflower mass of warts of horny consistence or, more commonly, as a warty nodule or a fissure. These soon become ulcers, with raised, everted, sinuous, and indurated edges, and a hard, warty, and irregular base which exudes an ichorous fluid. Lymph-node involvement is usually early and extensive.

Microscopically, these tumors consist of solid columns of epithelium, which have perforated the basement membrane and have grown into the connective or other underlying tissue. The columns are surrounded by an imperfectly fibrillated stroma or round connective-tissue cell infiltration. The epithelial cells penetrate into the lymph spaces and follow those channels which intercommunicate. Transverse sections of the epithelial masses show typical *epithelial nests.* When these cells become compressed they form concentrically arranged masses which undergo keratinization and are known as *epithelial pearls.* Mitotic figures are usually abundant in the epithelial cells, in many of which the peripheral prickles or spines can be detected. There is a marked tendency to degeneration, causing ulceration and hemorrhage, and extension occurs by direct infiltration and through the lymphatics.

Rodent Ulcer.

Rodent ulcer is the least malignant form of epithelioma, and arises in the dermis rather than from the surface epithelium ; hence the term *basal-celled epithelioma* employed by Krompecher. In some instances the disease may arise from the small cells lining the sebaceous glands, as suggested by Bland-Sutton, who gives them the name *sebaceous epithelioma.* It usually occurs on the face and is most common on the side of the nose, at the inner angle of the orbit, on the forehead, and the prominence of the malar bone. It is seldom seen in early life, the growth is very slow, and the lymph-nodes are rarely affected by secondary growths. The ulcer is flattened, the edges are raised, indurated, and smooth. Microscopically, it consists of irregular ingrowths from the basal epithelial cells, the new-formed cells being round and small, usually not more than one-third the size of the cells forming an epithelioma.

Teratoma.

There is a class of abnormal tissue growth, complex in its nature, varying from the double monster type to the compound tumor of misplaced embryonal tissue, which results from abnormal development of embryonic structures, to which the name *teratoma* is applied.

These tumors are derived from cells capable of giving rise to all the tissues of the individual, and are divided by Adami into twin and filial teratomata.

The *twin type*—of which the fœtal inclusion is an example—occurs as an autonomous growth, the product of the continued development within one individual of another individual of the same species.

The *filial type* is due to the segregation and subsequent growth of embryonal cells, which are capable of giving rise to all the different tissue types.

As examples of those growing from non-germinal blastomeres may be cited the epignathus, from excess production of growing point cells at the superior pole, and sacral congenital teratomata, formed in a similar way at the inferior pole.

A more common form of teratoma is that derived from the germinal blastomeres, to which group of tumors the term *embryoma* is frequently applied.

The germinal blastomeres may become misplaced and then appear as teratomata of the cranium, gill clefts, thoracic cavity, etc.; but even if they remain in the ovary or testicle they may still show a tendency, in post-fœtal life, to assume active properties of growth and become the testicular and ovarian embryomata, which are by no means uncommon.

These tumors, exceedingly complex in their structure, are derived from all three layers (epiblast, mesoblast, and hypoblast), and may contain a great number of different forms of tissue, such as various forms of fibrillar connective tissue, cartilage, bone, teeth, hair, skin, muscle, and glands.

While usually benign, these tumors may assume the most extreme malignancy—this character occurring in those tumors in which sarcomatous and carcinomatous elements are present.

There is another type of tumor, intermediate between the teratomata and the simple tumor, which, while not the product of the growth of all three germinal layers, is yet mixed in type.

To this group belong various tumors of the kidney, parotid, submaxillary gland, vagina, and breast.

Such tumors, of which fibro-adenomata, adenocarcinomata, and chondrosarcomata are examples, are considered *mixed tumors* because more than one type of tissue is present under conditions where these tissues have assumed the characters of the independent growths.

SPECIAL TUMOR TYPES.

A few tumors exist which are of unusual form and structure, which are not included in any of the common groups of tissue types.

These have distinctive names, and include peculiar tumors formed of fœtal or placental tissue, called *chorion epithelioma* or *deciduoma;* of tissue resembling the adrenals, *hypernephroma;* peculiar tumors of the dura mater, called *psammoma*, etc.

Deciduoma.

The name deciduoma has been applied to a form of uterine new growth occurring in connection with pregnancy which was formerly thought to occur as a result of the proliferation of the cells of the decidua, but which recently have been shown to have their origin more frequently in the chorion.

Between the benign form known as *hydatiform mole* and the malignant forms known as *syncytioma* or *chorionepithelioma* there is no sharp dividing line, although most hydatiform moles are clearly benign, and most chorionepitheliomata are excessively malignant. The tendency to the occurrence of chorionepithelioma after the formation of hydatiform mole is well marked, this connection having been established in about 40 per cent. of the cases on record.

Hydatiform or vesicular mole is a form of new growth having a resemblance to a bunch of grapes, which has its origin in the chorionic villi. The translucent vesicles, of which it is formed, contain a clear fluid, vary in size from that of a millet seed to an acorn, and spring from other vesicles or from the chorion by independent pedicles.

There is a tendency for the chorionic villi, in this condition, to infiltrate the uterine wall. The varying degree of this infiltration is a factor which makes the border line between the benign and the malignant deciduomata an indistinct one.

Recently attention has been called to the intimate relationship between the occurrence of hydatiform mole and lutein cysts of the ovary.

Chorionepithelioma.

The malignant form of *deciduoma* is usually known as chorionepithelioma. These tumors usually contain elements derived from both layers of the chorion—Langhan's cells and the multinucleated cells of the syncytium. Inasmuch as they always include the syncytial layer, they are sometimes known as syncytioma.

Their most important clinical feature is their tendency to produce frequent and profuse hemorrhage. They possess a great tendency to form early and extensive metastasis because of the proclivity which the chorionic epithelium exhibits of penetrating the capillaries. They are among the most malignant of tumors.

To the naked eye the tumor appears on section as a soft, reddish mass. Microscopically, it is composed of large polynuclear cells or cell masses—syncytial masses—appearing in regular multinuclear strands, and of more transparent, sharply circumscribed, polyhedral cells, with single oval nuclei. They often contain free blood and fibrin, and the stroma is largely made up of the tissue they invade.

Hypernephroma.

The name *hypernephroma* has been applied to a form of tumor found mainly in the kidney, arising from adrenal nests or masses of accessory suprarenal tissue, having the structure of the zona fasciculata of the suprarenal body.

As a rule, hypernephromata are malignant, although they may be benign. They occur most commonly in persons past middle life, and may form metastases, which extend along the blood stream to the lung, liver, muscles, and frequently to the long bones. In the kidney the tumor is usually encapsulated and situated near the cortex.

Hypernephromata histologically present wide variations which approach in type the carcinomata, endotheliomata, and angiosarcomata.

The stroma is composed largely of a network of capillaries, in the meshes of which the cells are enclosed. An alveolar appearance is often seen. The cells are large, polyhedral, and refractile, containing fat and glycogen droplets.

The cells, lying directly upon the endothelium of the capillaries, often present a tubular arrangement. Mitosis is frequently abundant, and the central areas of the tumors are very prone to undergo degeneration. Interstitial hemorrhages are common and often profuse.

While Lubarsch considered the presence of glycogen characteristic of hypernephromata, this view is no longer tenable, as many embryonic tissues and freely growing tumors contain glycogen in their cells.

Psammoma.

Psammomata are small lobular tumors, often multiple and pedunculated, growing from the inner surface of the dura mater or the pia mater. They are usually composed of tissue fibres, sarcomatous or endotheliomatous in character, and contain variously shaped calcareous concretions similar in appearance to the so-called brain sand.

CYSTS.

A cyst is a closed sac, containing fluid or pultaceous matter—a form of new growth, although not a tumor in the strict sense of the word. Cysts may be classified as follows:

I. Cysts formed by distention of pre-existing cavities.
II. Cysts of new formation.
III. Congenital cysts.

I. **Cysts Formed by Distention of Pre-existing Cavities.**—These are divided into three groups: (*a*) Exudation cysts; (*b*) retention cysts; (*c*) extravasation cysts.

Exudation cysts are those which arise from the distention of cavities which have no secretory ducts, such as thyroid, Graafian follicles, and bursæ. In the thyroid this gives rise to a cystic goitre. Graafian follicle cysts may be multiple, with coalescent walls and communications between adjacent cavities. These are not to be confused with cystadenomata and papillary cystadenomata. Bursal cysts occur most commonly in the larger bursæ—prepatellar and olecranon—and in those bursæ over the tuberosity of the ischium and the great trochanter.

Retention Cysts.—When the duct of a gland becomes obstructed, the secretion, hindered from escaping, accumulates and causes a dilatation of the ducts and acini.

Examples of this form are sebaceous and mucous cysts and the so-called duct cysts of the salivary and lacteal glands, liver, kidney, and testicle.

Sebaceous Cysts.—Sebaceous cysts or wens result from the occlusion of the orifice of sebaceous glands on the surface of the skin. The secretion collects and forms a tumor. These tumors are especially common on the face and scalp, but may occur on any part of the body. They are smooth, round, circumscribed, movable on the deeper parts, soft and putty-like in consistence, and contain inspissated creamy material. A small, black spot may sometimes be detected on the surface of the skin over them, where the occluded duct opened.

Mucous Cysts.—Mucous cysts are formed by the dilatation of mucous glands following obstruction of their ducts.

They are most common in connection with the salivary glands. When these occur in the mouth, they are known as *ranulæ.* Other common examples are the cysts formed by the dilatation of the glands of Bartholin at the entrance of the vagina.

Extravasation Cysts.—Extravasation cysts are formed by the extravasation of blood into closed cavities, as the tunica vaginalis of the testicle (hematocele), etc.

II. **Cysts of New Formation.**—These are divided into four groups:

(*a*) Serous cysts.
(*b*) Degeneration cysts.
(*c*) Parasitic cysts.
(*d*) Implantation cysts.

Serous Cysts.—Serous cysts are supposed to be formed by the accumulation of fluid as the result of irritation, pressure, etc., in the lymphatic spaces of the connective tissue, these spaces subsequently becoming fused into a single cavity. Adventitious bursæ developed over prominences of bone are the most common examples of this form.

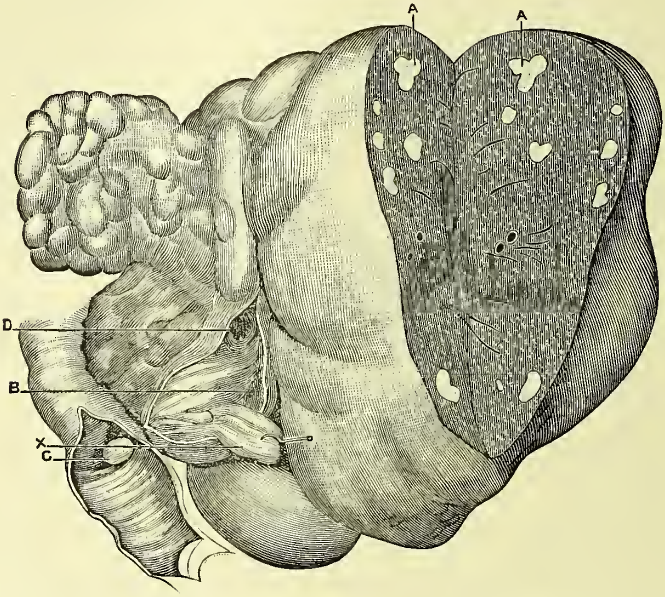
Degeneration Cysts.—Degeneration cysts result from degeneration and liquefaction occurring in the substance of tumors, especially those which are succulent and of rapid growth. Old abcesses may also change into well-defined cysts of this kind.

To this group may also be added the ganglia, which are cysts formed in connection with the connective-tissue structures about a joint, as in the sheath of a tendon, and are most commonly seen on the dorsal aspect of the carpus or tarsus.

Parasitic Cysts.—Parasitic cysts are produced by the growth within the tissues of cyst-forming parasites, the best known being the tænia echinococcus, which gives rise to the *hydatid cyst.*

Although hydatid cysts may occur in any of the tissues and organs of the body, they are most frequently found in the liver (Fig. 20).

FIG. 20.



Large hydatid cyst of the left lobe of the liver and multiple abscesses of the right lobe, *a, a*; *d*, cyst breaking into the common duct; *c*, ampulla of Vater. (Lancereaux.)

The ova of the parasite, transmitted from the dog, gain admission to the human intestine, are there hatched, and the embryos are thence transported to some other part of the body, usually by the portal vein, where they lodge and form cysts. These cysts are formed of an external laminated elastic layer, the ectocyst, and of a lining membrane or parenchymatous layer, the endocyst. From this inner layer brood capsules may develop from which *daughter cysts* may form, and from these in turn *granddaughter cysts* may develop.

Implantation Cysts.—Implantation cysts, or traumatic dermoids, are formed by the displacement of portions of the epidermis through a punctured wound into the underlying connective tissue. The displaced epithelium proliferates and forms a small cyst, the most frequent site of which is on the palmar aspect of the hand and fingers.

III. **Congenital Cysts.**—These are divided into two groups:

(*a*) Dermoid cysts.

(*b*) Cysts from persistent fœtal structures.

Dermoid Cysts.—Dermoid cysts of the simplest form, known as sequestration dermoids, arise in detached and sequestrated portions of the surface epithelium, mainly in situations where, during embryonic life, coelescence takes place between skin-covered surfaces. They are found in the mid-line of the trunk, from the occipital protuberance along the spine to the coccyx, through the perineum (including the scrotum and penis) and through the mid-line of the abdominal and thoracic wall of the neck. In the face and neck they arise in the lines of the facial and branchial fissures.

A dermoid occasionally takes the form of a recess lined with skin, examples of which are *postanal dimples*, the *coccygeal* or *pilonidal sinuses;* but more commonly it assumes the form of a globular tumor, consisting of a central cavity lined by stratified squamous epithelium. This cavity is filled with a turbid fluid containing desquamated epithelium, fat-droplets, cholesterine crystals, and detached hairs.

Ovarian dermoids differ in several respects from the preceding. They arise from the epithelium of the ovarian follicles, and take the form of unilocular or multilocular cysts, the wall of which contains skin, mucous membrane, hair follicles, sebaceous, sweat, and mucous glands, nails, teeth, nipples, and mammary glands.

The cavity of the cyst usually contains a pultaceous mixture of shed epithelium, fluid fat, and hair.

Cysts from Persistent Fœtal Structures.—These occur in obsolete canals and functionless ducts.

Among the former, existing in the human embryo, but usually disappearing before birth, are the *thyroglossal* duct, the *branchial clefts*, and the *postanal gut.* Cysts derived from these structures are frequently called *tubulodermoids.*

Cysts of the latter, frequently called *tubulocysts,* arise in connection with the *vitello-intestinal* and Gärtner's ducts, the *urachus,* the *paroöphoron,* and the *parovarium.*

CHAPTER VI.

SHOCK AND ALLIED CONDITIONS.

Shock.

As a result of painful injury or strong mental emotion a condition of depression results which is called *shock,* the symptoms of which may vary from a slight feeling of weakness accompanied by nausea, and perhaps a temporary loss of consciousness, to complete paralysis of all the vital processes resulting in speedy death. In general it may be stated that the degree of shock depends upon the character and extent of the injury, its location, the kind of tissues involved, the amount of hemorrhage, the temperament and mental condition of the individual. Thus extensive burns and scalds produce a relatively greater degree of shock than other purely superficial injuries; severe crushes involving all the tissues of an extremity, and injuries involving large areas, cause more shock than wounds and lacerations limited to the soft tissues and covering only a limited extent of the body. As loss of blood alone will produce a condition very similar to shock, it is evident that injuries associated with any considerable degree of hemorrhage will be accompanied by more profound shock than bloodless injuries of the same extent and character. Individuals possessing highly developed nervous organizations, as a rule, react more to slight injuries than the more phlegmatic, and in such persons the anticipation of injury or pain will often greatly accentuate the resulting symptoms; as, for example, a highly nervous though otherwise healthy and vigorous man will often faint at the sight of a drop or two of blood during a vaccination, whereas another individual will bear without the slightest evidence of shock a severe trauma or painful surgical operation without anæsthesia.

Although the condition known as shock has been recognized for centuries by surgeons, and much has been written on its prevention, symptomatology, and treatment, yet until quite recently little or nothing was known definitely regarding its true nature. Goltz, of Strasburg, was perhaps the first to recognize the importance of vasomotor paralysis as a causative agent in shock, when in 1870 he made the experiment of tapping the mesentery of a frog with the handle of a scalpel, and noted temporary cessation of heart action followed by a greatly diminished output of blood into the aorta. Other writers, including Eisemann, sought to explain the phenomena of shock on the theory that the functions of the brain were impaired by anæmia caused by contraction of the blood-vessels; while Blum and others attributed the symptoms to a reflex irritation of the pneumogastric nerve causing diminished heart action. Fisher taught that as a result of vasomotor paralysis large quantities of blood accumulated in the larger veins, especially the abdominal, and, as a consequence, the heart and other portions of the vascular system were comparatively empty, a condition similar to that caused by extensive hemorrhages.

Crile, in his masterly essay, entitled *An Experimental Research into Surgical Shock*, has shown that all of these elements may be present in a given case of shock. His carefully conducted experiments have conclusively demonstrated that as a result of severe mechanical injury afferent impulses are conveyed to the brain by the sensory nerves and give rise to efferent influences which cause embarrassment of respiration, a diminution or arrest of heart action, and a disturbance of vasomotor control. While all of these factors are present in cases exhibiting evidences of any considerable amount of shock, injuries in certain regions of the body seem to result in accentuation of one or more of these factors; as, for example, injuries to the interior of the larynx and of the thoracic cavity cause striking evidences of respiratory failure; injuries of the male genital organs and trauma of the pericardium or adjacent portions of the diaphragm cause irregularity, weakness, or arrest of the heart action; while irritation of the peritoneum, especially that portion covering the small intestine, gives rise to marked dilatation of the splanchnic veins and consequently lowered blood-pressure. In a large number of Crile's experiments it was found that the first effect of a given trauma was a rise in the blood-pressure, which afterward gradually fell to the normal or below. If the experiment was repeated, the preliminary rise was less marked and the fall was greater in extent. After repeated applications of the injuring force it was observed that the preliminary rise did not occur, but that a progressively lowering blood-pressure resulted. Injury of certain highly organized tissues, as the interior of the larynx, the brain, the testicle, and the abdominal viscera, was often followed by a rapid fall of blood-pressure without the preliminary rise. While the exact nature of the change in the vasomotor centers is not definitely known and cannot be demonstrated, its effect is practically always the same, and consists in an abnormal lowering of the blood-pressure. This is the primary and essential factor in shock; all of the other manifestations can be explained by the effect of this loss of vascular tone upon the brain and other organs. Crile's experiments also prove that the integrity of the circulation—that is, the maintenance of the blood-pressure—depends in large measure upon the regularity and force of the heart's action. The output of the heart in turn depends upon the pressure in the vena cava ; the venous pressure depends upon the integrity of the vasomotor mechanism. Thus any agent which produces weakened heart action, vasomotor paresis, or a diminished venous blood-pressure, will favor the occurrence of all of these factors. When this condition is present, it is obvious that comparatively little blood is in circulation, the greater bulk being stored in the paralyzed and dilated venous system. As a result, the supply of oxygen to the tissues is greatly diminished, and the effect of this on the central nervous system is to produce impairment or cessation of all of its functions.

The effect of lessened blood-pressure on the respiration is strikingly apparent in many of Crile's experiments. Whenever an injury resulted in marked vasomotor paresis the respirations became shallow, irregular, and often ceased entirely, requiring artificial respiration. In 90 out of 103 experiments respiratory failure was the immediate cause of death. While the belief is very general among the profession that in shock the chief danger lies in heart-failure, Crile has shown that in all probability the heart is the one factor most to be depended upon in this condition. The apparent weakness of the heart is not so much due to exhausted heart-muscle as to the fact that the amount of fluid in its cavities is so reduced that its output is necessarily small, and its rapid action is an effort to increase this output and raise the blood-pressure. This is abundantly proved by the prompt restoration of function often seen as a result of intravenous saline infusion without any other stimulation.

Sudden irregularity and weakness of the heart's action, with a rapid and exaggerated fall of the blood-pressure, occasionally follow certain grave injuries, which can only be explained by a strong inhibitory reflex vagal influence. To this condition the term *collapse* is generally applied.

Causes.—Shock may be caused by any agency producing a violent impression upon the central nervous system through the medium of the nerves of sensation or special sense. The occurrence of syncope, or even death, has frequently been observed to follow some violent emotion, hearing bad news, or witnessing a horrible or revolting spectacle. With these causes, however, the surgeon has little to do. Surgical shock in the great majority of instances is caused by bodily injury the result of trauma or surgical operation. In both of these conditions hemorrhage may play an important part, and in the latter the depressing influence of the anæsthetic may add a potent factor.

Regarding the conditions which favor the occurrence of shock, it may be stated in general that lowered vitality from any cause, and an abnormally impressionable nervous system, are the conditions in which a severe degree of shock may be expected. Thus infancy and old age, wasting disease, malnutrition, exhaustion from suffering or prolonged physical effort, chronic toxæmia from alcohol, drugs, uræmia, tuberculosis, syphilis, etc., as well as conditions of neurasthenia, hysteria, and fright, are to be regarded as predisposing factors in this condition.

Crile has shown that injury or even irritation of certain regions of the body gives rise to a far greater degree of shock than more severe trauma elsewhere. In general the rule holds good that "the more specialized and abundant the nerve-supply to a part, the more will it contribute to the production of shock when subjected to injury." He found that comparatively slight injury to the mucous membrane of the interior of the larynx produced sudden cessation of respiration, cardiac weakness, and a rapid decline in the blood-pressure, even when the animal was under general anæsthesia. After division of the superior laryngeal nerves or cocainization of the parts these effects were not apparent. Direct pressure on the heart, pericardium, and great vessels produced great irregularity and weakness of the heart and a lowering of blood-pressure. Tapping the under surface of the diaphragm caused marked respiratory disturbance and cardiac weakness. Injuries of the brain, spinal cord, testicle, lung, upper segment of the intestine, and mesentery, and manipulation in the region of the pylorus, gall-bladder, and duodenum, all caused an exaggerated degree of shock; while injuries of the pelvic organs (especially in the female), of the liver, spleen, and kidneys, gave rise to comparatively little disturbance. Incisions or wounds in the skin gave rise to a far greater degree of shock than such injuries in the muscles, tendons, fatty tissues, and fasciæ. Injury of or even traction upon nerve-trunks was accompanied by considerable systemic disturbance; while injuries of the bones and large joints, when unaccompanied by nerve-lesions, produced little reaction. When the animal was in a condition of shock from repeated trauma or had recently passed through such a condition, it was found that further injury, even of moderate degree, was accompanied by a lowering of the blood-pressure that was wholly out of proportion to the degree of injury, and from which reaction was very much delayed or absent.

Symptoms.—These vary in proportion to the degree of injury and the susceptibility of the patient. In mild cases the patient complains of a feeling of weakness, slight nausea, and giddiness. The face is pale, the extremities cool and often bathed in perspiration, the pulse is weak, and there is a tendency to syncope if he is in the upright position. In severer cases there may be a temporary loss of consciousness; the patient is unable to sit up, lies quietly, and takes little or no interest in his surroundings; will answer questions; does not complain of pain; and asks only to be let alone. In the severer cases consciousness is almost entirely suspended; the face is expressionless; the eyes are fixed, the pupils dilated, reacting slowly to light; there is no apparent suffering even though a portion of the trunk may be extensively mangled or an extremity crushed. The surface of the body is cold and moist; the pulse is rapid, irregular, compressible, and extremely weak; the temperature is subnormal; the patient makes no effort to move, but lies in any position in which he is placed. Vomiting may occur, and in alcoholics tremor and delirium. Exceptionally in the severest cases, restlessness and delirium may, in non-alcoholics, be the most prominent symptoms. These conditions render the prognosis extremely grave.

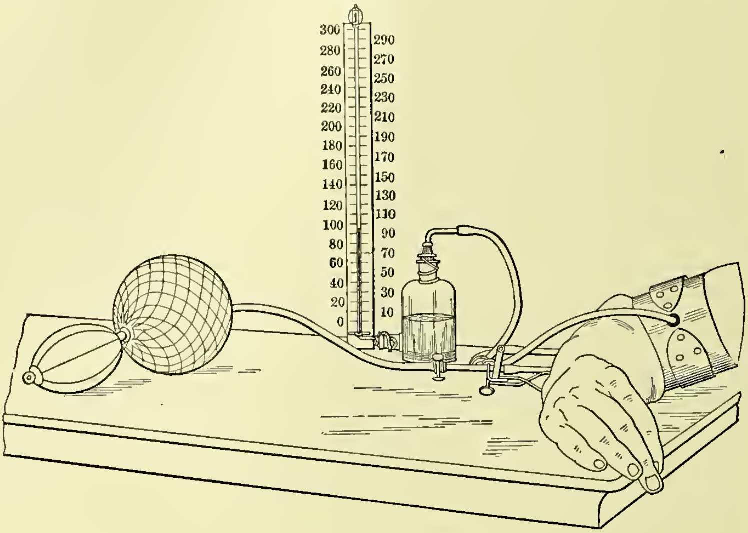
Shock and hemorrhage have so many symptoms in common that it is often difficult or impossible to make a differential diagnosis. The question may be a serious one, especially after operations, as it is most important to know whether a given condition of weakness is due simply to shock of operation or to a concealed hemorrhage. In general it may be said that in shock the patient is weak and apathetic, while in hemorrhage he is weak and restless.

Prognosis.—The prognosis in severe shock is always grave, and until there is a decided and sustained improvement from the stimulant measures employed, the outlook should be regarded as uncertain. In the milder cases recovery may be expected if the cause or causes of the depression can be removed and appropriate treatment carried out. Conditions which add to the gravity of a given case are the combination of shock with hemorrhage, anæmia, delirium tremens, brain injury, arteriosclerosis, or a heart weakened by chronic valvular disease, myocarditis, or fatty infiltration.

Treatment.—The indications for treatment in a condition of shock are to restore the temperature of the body, overcome the vasomotor paresis, increase the strength of the heart action, stimulate the central nervous system, and prevent further afferent sensory impulses from the injured area. The patient should therefore be moved to his bed with as little injury as possible, wrapped in warm blankets, and have heat applied externally by hot bottles or rubber bags, and internally by hot drinks or copious rectal irrigations of hot saline solution. Hemorrhage should be controlled, and if possible sensory impulses from the injured area blocked by the hypodermic injection of cocaine (1 per cent.) in the neighborhood of the nerve-trunks. Strychnine and atropine should be given hypodermically, the former for its action on the heart-muscle and vasomotor centres, the latter to prevent the inhibitory vagal influence so often present in shock. Whiskey should be administered by the mouth, hypodermically, or by the rectum. If given by the bowel, it may with advantage be combined with hot coffee. Perhaps the most satisfactory stimulant under these conditions is the intravenous infusion of hot normal salt solution. This should be given at a temperature of 116° to 118° F., and in sufficient quantity to produce a distinct improvement in the heart action and pulse. Repeated infusions of a comparatively small quantity of the solution, apparently, have a better effect in the absence of hemorrhage than a single large infusion. In the milder degrees of shock, especially when the patient is conscious of suffering, and occasionally in the severer forms, the hypodermic use of full doses of morphine seems to be of value; camphor and digitalis may also be employed. As vasomotor paresis is one of the most important elements in shock, the use of nitroglycerin, or other vasomotor dilators, is to be condemned. Recent experiments by Crile and others have demonstrated the great value of intravenous infusions of adrenalin in normal salt solution. This agent acts directly on the vessels, stimulating the constrictor fibres and raising the blood-pressure.

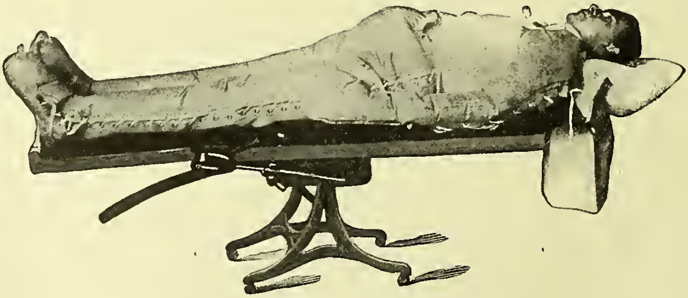
As a general rule, surgical operations should not be undertaken during a condition of severe shock. To this rule, however, there are many exceptions, for hemorrhage must be controlled, penetrating wounds of the head, thorax, or abdomen must be disinfected and protected, strangulated hernias must be relieved, and the irritation resulting from extensive lacerations of the tissues and nerve-trunks must be controlled when it acts as a cause of progressively increasing shock. Under these conditions, when general anæsthesia is necessary, ether should always be employed, preceded by the hypodermic use of morphine, strychnine, and atropine, and an enema of hot coffee. An intravenous saline infusion should be administered as soon as the patient is under the anæsthetic, and continued during the progress of the operation. Under the influence of the ether and other stimulants the condition of the patient will sometimes change for the better during the operation, especially if an extensively mangled extremity is quickly amputated and a comfortable dressing applied. Operations in shock should be carried out with the maximum of speed, and the minimum of anæsthesia and exposure on the table. Elaborate preparation of the wound-area should not be undertaken in cases with infection well established, as the chances of successfully treating an infected wound are far greater than of combating an increased degree of shock from delay and prolonged exposure. Harvey Cushing has recently emphasized the importance of watching the blood-pressure during operations which are apt to be accompanied by severe shock, as variations in pressure are far more significant in indicating impending shock than changes in the pulse-rate. For this purpose he employs the Riva-Rocci apparatus, which consists in a pneumatic rubber bracelet which is made to encircle the arm; this is connected by means of a rubber tube with a mercury manometer, by which the blood-pressure is indicated with a fair amount of accuracy by the column of mercury (Fig. 21).

Fig. 21.



Riva-Rocci manometer.

Fig. 22.



Crile's pneumatic rubber suit.

The use of the pneumatic rubber suit, as recommended by Crile, with a view to driving the blood from the extremities and trunk into the brain, has proved of positive value (Fig. 22).

In undertaking operations on patients suffering from shock, or where, from the nature of the operation, considerable shock is to be expected, it is of advantage to operate at a time when a patient is in the best physical condition to withstand depressing influences. Generally speaking, most patients are at their best in the early part of the day, as the period from six in the morning until two in the afternoon is the one of greatest vitality and, consequently, greatest resistance. At a later period, septic patients show their evening rise of temperature, and weak and exhausted individuals become nervous, restless, and manifest other evidences of lowered vitality and resistance. Other things being equal, night operations should be avoided, unless the delay involves danger of increased shock or grave complications, as in cases of hemorrhage, advancing sepsis, intestinal obstruction, or cerebral compression.

In highly nervous and apprehensive individuals the dread of operation not infrequently gives rise to a very considerable diminution in their normal resistance. In such cases the hypodermic injection of a moderate dose of scopalamine and morphine two hours before operation will be of decided assistance, not only in the relief of the nervous tension, but in greatly diminishing the amount of ether or chloroform used.

Hemorrhage.

Hemorrhage, or the escape of blood from the vessels, occurs as a result of trauma, surgical operation, or disease. Traumatic hemorrhage may be *external*, if the loss of blood occurs from a wound of the skin or soft parts; *internal*, or concealed, if the bleeding occurs into one of the cavities of the body; or *subcutaneous*, if it takes place into the soft tissues beneath an unbroken skin.

A hemorrhage is said to be *primary* when it occurs at the time of the trauma; *intermediate* or *recurrent*, when it occurs after a few hours—twelve to forty-eight; *secondary*, when it occurs after a few days—from two to the complete healing of the wound. Bleeding may occur from the arteries, veins, or capillaries, or from all combined. *Arterial* hemorrhage is generally recognized by the bright scarlet color of the blood, and by the fact that it occurs in jets synchronous with the pulse; *venous* hemorrhage, by the steady flow of dark-colored blood which is easily controlled by pressure; *capillary*, by the general oozing of blood from a large area of divided tissue. Extensive subcutaneous hemorrhages, if arterial, give rise to large pulsating tumors—*false aneurisms;* if venous, to large collections of blood—*hæmatomata*—which do not pulsate (unless situated immediately over an artery), and in which the sensation of fluctuation can be obtained. *Ecchymoses,* or "black and blue marks," represent subcutaneous hemorrhages too small in amount to form distinct tumors.

Hemorrhage from disease may occur in the brain — *cerebral apoplexy*—where it is generally the result of endarteritis; from the nose—*epistaxis*—where it results from congestion or ulceration of the mucous membrane; from the lung—*hæmoptysis*—which is often the earliest symptom of tuberculosis; from the stomach—*hæmatemesis*—caused by new growth, ulcer, passive congestion, or intense inflammation; from the bowels—*melæna*—from tumors, acute or chronic ulceration, or congestion; from the urinary organs—*hæmaturia*—from new growth or disease of the kidney, bladder, prostate, or urethra.

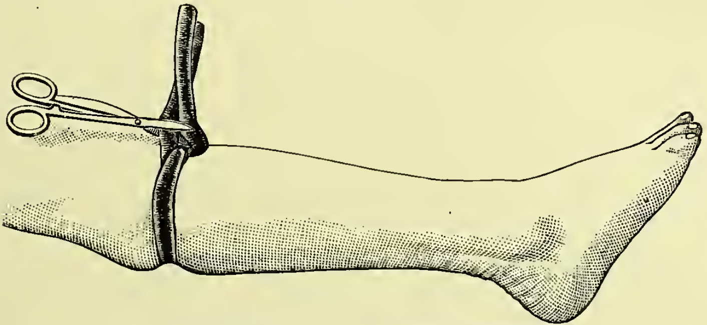
Alarming hemorrhages occasionally occur from slight and insignificant traumata, due to an hereditary condition known as *hæmophilia.* Little is known regarding the etiology of this condition other than the fact that this tendency to hemorrhage is transmitted from one generation to another. Such individuals are called *bleeders,* and they should not be subjected to surgical operation except under conditions of extreme emergency.

Symptoms.—A moderate loss of blood in a vigorous, healthy individual produces no symptoms other than a feeling of slight weakness. If the amount lost is greater, there is a feeling of giddiness, dyspnœa on exertion, mental confusion, and a disposition to faint. In severe cases there may be in addition thirst, air-hunger, partial blindness, ringing in the ears, and suspended consciousness. Accompanying these symptoms there are pallor, coldness of the extremities, a moist, clammy skin, rapid, sighing respiration, and restlessness. The pulse is rapid, feeble, thready, irregular, and compressible; the temperature is subnormal; there is great physical weakness; nausea and vomiting may occur; the pupils are dilated, the eyes often fixed, and the countenance expressionless. In continued hemorrhage these symptoms are all exaggerated, consciousness is lost, tremor or convulsions may be present, the pulse becomes imperceptible, the heart fluttering, and death speedily occurs. Da Costa states that death may be expected if one-half the volume of blood is lost. It often occurs with much smaller hemorrhage if the loss is rapid or accompanied by shock from other causes.

Treatment.—Nature's method of arresting hemorrhage is by the formation of a clot in or about the wound of the vessel. This forms first around the opening, then extends into the lumen of the vessel, and if undisturbed causes its permanent closure. Clotting occurs early in wounds of the smaller vessels, especially the veins, which collapse more readily than the arteries, and prevents a serious loss of blood. In wounds of the larger vessels, however, the force of the blood-current prevents the formation of a clot until the vascular tension is greatly lowered, often after the patient has fainted. The lessened force of the blood-current, which results partly from the diminished volume of blood in the vessels and partly from vasomotor paresis from cerebral anæmia, together with a condition of greater coagulability of the blood apparently present under these circumstances, finally results in the formation of coagula in the mouths of the vessels and arrests the hemorrhage before death occurs. In wounds of the larger trunks the patient is quickly exsanguinated and death results before nature's processes have begun.

In the treatment of hemorrhage from any vessel of considerable size only one method should be employed by the surgeon, and that is, to expose, isolate, and securely ligate the bleeding artery or vein. No other method gives the same degree of safety to the patient or the same feeling of security to the surgeon. Many circumstances, however, may be present which will prevent the carrying out of this plan, and under these conditions other methods must be employed. The application of a tourniquet above the bleeding point is perhaps the method most generally employed for the temporary arrest of severe hemorrhage from an injured limb. In the absence of a regularly constructed tourniquet, the best material for this purpose is a medium-sized piece of rubber tubing (Fig. 23), large enough to avoid cutting the skin and sufficiently elastic to exert considerable pressure when snugly applied. This should be made to encircle the limb, should be well drawn out, and tied or securely held by forceps, care being taken to avoid pressure on the nerve-trunks. In the absence of rubber tubing any strong material may be used, as a flannel or muslin bandage, a strip of folded cotton or linen cloth, or even a skein of worsted. These should be tied tightly about the limb and additional press-

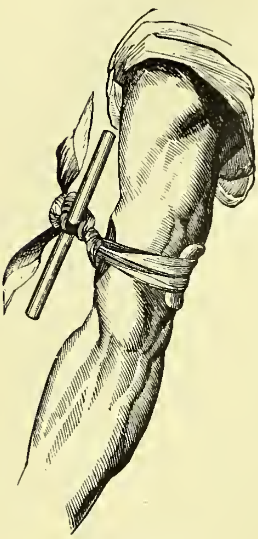
FIG. 23.



Rubber tubing applied to arrest hemorrhage.

ure exerted by twisting with a stick (Fig. 24). *Digital pressure* at the bleeding point or over the artery supplying the part will often be serviceable in temporarily arresting a hemorrhage until other and more permanent means can be employed. *Mechanical compression* by means of sponge or gauze packing applied to the bleeding point and firmly held by a bandage is serviceable, especially in venous bleeding or capillary oozing. *Hyperflexion* at certain joints, as the knee and elbow, with or without a pad of gauze or cotton at the angle of flexion, will often serve to compress the artery and arrest hemorrhage. The flexion should be maintained by bandage, and can be borne only for a short time. *Elevation of the limb* causes at once a diminution in the amount of blood lost, and in connection with other temporary measures will often be successful. The application of *hot water* or *ice* to a bleeding part is often employed with success in venous and capillary oozing. Certain chemical agents, called *styptics*, have the power of producing firm clots, and are occasionally employed, especially in the throat and nasal cavities. Of these, the persulphate of iron in powder or solution (Monsel's solution or salt) has been most frequently employed. Tannin, alum, antipyrin, cocaine, and adrenalin are also extensively employed, the two last chiefly on mucous membranes. Strong hydrogen peroxide has been found by the writer to be useful in controlling capillary oozing in wounds, and also in mucous membrane hemorrhages, and has the advantage of being as well a powerful antiseptic agent. The *actual cautery* will occasionally be found of value in arresting hemorrhage, especially from the cut surface of bone, or the oozing from divided inflammatory tissues.

Fig. 24.

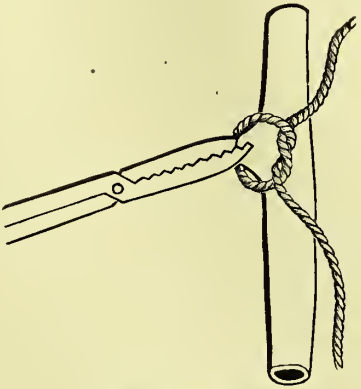


Spanish windlass.

Of the methods applicable directly to the bleeding vessel, ligature, torsion, acupressure, and suture may be employed.

Ligature.—The wound should be held apart by retractors, and sufficiently enlarged to obtain a good view of the bleeding point; the vessel should be separated from the surrounding tissues and clamped. If an artery has been completely divided, both ends should be found, clamped, and ligated. If it has sustained a lateral wound, it should be clamped above and below the wound, divided, and each end securely ligated. If a vein is found to be the source of the hemorrhage, the bleeding end should be tied. In small lateral wounds of large and important venous trunks the wounded edges should be grasped by a clamp and a lateral ligature applied (Fig. 25). In friable inflamed tissues, in sloughs, in the dura mater, and often in disease of the vessel-walls, the application of a ligature by means of a curved needle passed around the vessel through the surrounding tissues is to be recommended. When possible, absorbable ligature material should be employed. For small vessels and in wounds which are expected to heal primarily ordinary sterile catgut is to be preferred. For the large arteries, and often in wounds which are left open or are expected to suppurate, chromicized catgut or silk may be employed.

FIG. 25.



Lateral ligature.

Torsion.—Twisting the divided end of an artery will often arrest bleeding by rupture and inversion of its inner coats. It has the advantage of leaving no foreign material in the wound, which in plastic operations may occasionally prevent accurate coaptation. Small vessels may be successfully closed by simply making two or three revolutions of the clamp. In large vessels the surrounding tissues should be removed and the exposed artery held gently by a forceps while the end is clamped and twisted.

Acupressure.—An old method seldom used at present. It consists in introducing a needle or harelip-pin through the skin under the vessel and applying pressure by means of a figure-of-eight ligature or by twisting the pin over the vessel and forcing it again into the tissues.

Suture of a Wounded Vessel.—Wounds in large venous trunks, too large to be closed by lateral ligature, may often be sutured with fine silk. The sutures should be introduced with a fine round needle, and should include all the coats of the vessel. In arterial wounds the problem is far more difficult, owing to the fact that the blood-pressure is higher, and the fact that the sutures are apt to tear out by the alternating dilatation and contraction of the vessel wall. In the majority of instances, however, if the arterial wall is in a normal condition, carefully introduced fine silk sutures will be successful in closing a longitudinal wound. In more extensive wounds, division of the vessel and end-to-end anastomosis by the method of Carrel should be employed (see page 151). In cases of abnormally high arterial tension, and in cases of thickened and calcareous arterial walls, closure of small wounds may be accomplished by the use of an aseptic rubber adhesive plaster, which is wrapped around the vessel and allowed to remain imbedded in the tissues. The writer demonstrated the feasibility of this plan by a series of animal experiments which were reported to the New York Surgical Society in 1904.[1]

In the treatment of *recurrent* and *secondary* hemorrhages pressure may be tried if no important vessels are involved and if the bleeding is moderate. In all other cases the wound should be opened and the bleeding vessel secured. This in recurrent or intermediary hemorrhage is generally easy; but in secondary hemorrhage, where the bleeding is usually due to necrosis of the vessel-wall from infection of the surrounding tissues, considerable difficulty may be experienced, and ligature of the main arterial trunk above the wound may be indicated.

The treatment necessary to overcome the systemic effect of a severe hemorrhage consists in absolute rest in bed with the head lowered and the trunk and extremities elevated. The heart should be stimulated by whiskey, strychnine, digitalis, and atropine; and the volume of blood increased by direct transfusion or by a large intravenous infusion of normal salt solution. Heat should be applied to the surface of the body by means of warm blankets and hot-water bottles; fluid food should be taken by the stomach or given by the rectum. In severe cases with recurring syncope death can sometimes be averted by applying elastic bandages to all four extremities, thereby forcing all available blood into the vessels of the trunk and brain. The after-treatment should consist in rest, an abundance of nutritious food, with iron, arsenic, and large quantities of beef-juice, bovinene, or beef peptonoids. Calcium chloride or lactate in full doses is highly recommended for persistent capillary hemorrhages; also before operation when a strong tendency to hemorrhage is known to exist.

The treatment of special hemorrhages associated with visceral and other traumata will be considered elsewhere.

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[1] "Annals of Surgery," December, 1904.

Uræmia.

The effect of a severe trauma, septic disease, or surgical operation requiring general anæsthesia in individuals who have kidney disease, is often to provoke an acute exacerbation of the trouble and to produce a fatal toxæmia. While the anæsthetic is, in the majority of instances, the chief cause of the disturbance, the condition of sepsis, the shock of trauma or operation, and loss of blood, by lowering the resistance of the patient, may act as contributing causes. While any disease of the kidneys which impairs their function may give rise to uræmia after operation, the condition known as chronic Bright's disease, associated with both parenchymatous and interstitial changes in the organs, and the cases of septic pyelonephritis which have passed the acute stage and in which the disease often exists as a latent disorder for a long period of time without symptoms, are the conditions most to be feared. As the embarrassment of the renal function in these cases is due largely to an acute hyperæmia of the organ produced by the elimination of large quantities of the anæsthetic, and often other toxic substances generated by the anæsthetic or the disease for which the operation is undertaken, the length of operation and amount of the anæsthetic agent used, as well as the method of its administration, will be found to be important factors. Long exposure on the operating-table with insufficient covering, especially if large quantities of cold water are used in the preparation of the patient, will favor renal congestion by lowering the surface temperature.

Symptoms.—The symptoms of toxæmia from renal insufficiency are too well known to need description; apathy, somnolence, a dry foul tongue, a high-tension pulse, diminished secretion of urine, and the general appearance of illness, with an increase in the temperature and other evidences of wound infection, should always excite suspicion of renal trouble, and measures should at once be undertaken to promote elimination and prevent further poisoning. In these cases examination of the urine will show it to be scanty, albuminous, and often bloody; casts are present and the output of solids is diminished. In the severe cases there may be absolute suppression of urine with a rapidly developing coma, Cheyne-Stokes respiration, convulsions, and death.

Treatment.—Early treatment is often of great value in this condition, and lives are frequently saved by judicious management. The administration of large quantities of water by the mouth, saline rectal irrigations, intravenous infusions, hot-air baths, cathartics, digitalis, nitroglycerin, dry cups over the loins, milk diet, and general stimulating measures are to be employed.

All patients with evidences of renal disease should, if possible, be subjected to a careful preparatory treatment before operation, consisting in free catharsis, copious draughts of water, and an absence of highly nitrogenous food.

Acid Intoxication.

The high death-rate following operations in diabetics is to a large extent due to a condition of excessive acidosis, to which the term *acetonæmia* has been generally applied. In certain conditions of bodily metabolism, due to a variety of causes, but chiefly observed in individuals suffering from diabetes, acetone is present in the blood, alone or associated with diacetic and β-oxybutyric acids. A minute trace of acetone is normally present in the blood and urine, but the quantity is too small to give a positive reaction when the ordinary chemical tests are applied. When acetone is present in the blood in any considerable amount, and especially when associated with diacetic and β-oxybutyric acids, the condition is spoken of as acid intoxication, excessive acidosis, or acetonæmia. This causes a diminution in the normal alkalinity of the blood upon which depends its ability to absorb carbon dioxide from the tissues, and the result is a group of alarming and often rapidly fatal symptoms, due in part to carbon dioxide poisoning, and in part to the toxic action of the β-oxybutyric and possibly other volatile fatty acids. The symptoms of this condition are generally those of diabetic coma; somnolence, and a progressively deepening coma associated with a peculiar sweetish, ethereal odor to the breath, resembling that of a pippin apple or chloroform. Another characteristic symptom is the air-hunger described by Kussmaul, in which the patient breathes rapidly and deeply, the skin and mucous membranes remaining bright red from the absence of carbon dioxide in the blood. In certain cases the coma is preceded by a period of mental disturbance resembling delirium tremens, in which the patient screams, gesticulates wildly, and gives other evidences of extreme fright. In most of these conditions acetone and diacetic acid can be demonstrated in the blood and urine. The condition is generally fatal, death occurring in from twenty-four to forty-eight hours from the onset of the symptoms. Acidosis occasionally follows operations in non-diabetic patients, due to the anæsthetic (especially chloroform), sepsis, or gastro-intestinal irritation. These cases are often spoken of as cases of *late chloroform-poisoning*. In certain instances the acetone reaction may be wanting, but jaundice is present with the delirium and coma. In practically all of the cases following the use of chloroform in non-diabetic subjects, the pathologic finding is the same—*i. e.*, an acute degeneration of the liver. Animal experiments have demonstrated that as a result of chloroform-poisoning the liver can be so completely degenerated in the course of two or three days that hardly a normal liver cell can be seen by microscopic examination.

The writer was the first to report a death from post-operative acidosis in a non-diabetic subject.[1] Since that period the subject has received considerable attention, and a number of clinical and experimental reports have been published. From our present knowledge it is possible that a mild acid intoxication may follow operation, due to the anæsthetic, starvation, sepsis, or gastro-intestinal disturbances not necessarily associated with a grave degree of liver degeneration; and that these cases may recover under appropriate treatment. It is also probable that the toxæmia which accompanies the severer types of liver degeneration, and which is almost invariably due to chloroform, may not give rise to the acetone reaction. In the majority of instances, however, the two conditions are associated and constitute one of the gravest of surgical complications.

Treatment.—In the treatment of acidosis an effort should be made to effect rapid elimination of the poison and to restore the normal alkalinity of the blood. To this end, cathartics and diuretics should be given, with bleeding, and the intravenous injection of from 3 to 6 drachms of chemically pure sodium bicarbonate, preferably given in a quart or more of normal salt solution. In the grave cases exhibiting marked jaundice with a progressive toxæmia there is no treatment which holds out any hope of relief. The condition is practically the same as in the other forms of acute yellow atrophy of the liver.

Cardiac Weakness.

Pathologic conditions of the valves of the heart or of the myocardium may result in a weakening of the organ and an inability to bear the strain of a surgical operation. While it has long been recognized that *valvular disease* of the heart, if uncompensated or associated with dilatation and the evidences of obstructed circulation, is a serious contraindication to general anæsthesia and surgical procedures, it is now pretty generally accepted by the profession that valvular disease if fully compensated, and if not accompanied by circulatory disturbances under conditions of moderate physical exertion, does not necessarily deter the surgeon from administering an anæsthetic and undertaking important operations. These conditions are, moreover, easily recognized by physical signs and the clinical history of the case, and the surgeon can be on his guard for evidences of heart-weakness, which generally precede by some time any serious change in its functional activity. It is the *myocardial changes* which are most to be dreaded, for these present, as a rule, no physical signs, and often are unaccompanied by any symptoms of cardiac disease until the fatal attack. Pathologic conditions of the myocardium resulting in cardiac weakness are due to a number of causes, among which may be mentioned infectious diseases, septic processes, the chronic toxæmias (from syphilis, tuberculosis, nephritis, diabetes, and alcoholism), general arterial sclerosis, obstruction of the coronary arteries, and obesity. These result in degenerative changes, sclerosis, and fatty infiltration. This condition may give rise to no symptoms or physical signs; occasionally the pulse is feeble, abnormally slow or fast, with attacks of arrhythmia and dyspnœa on exertion; the first sound may be weakened, and occasionally a blowing murmur is present.

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[1] "Annals of Surgery," October, 1902.

In these cases death may occur without warning on the operating-table, or from some slight exertion while recovering from the anæsthetic. In other instances the patient may become gradually cyanosed during the operation, with an increased rapidity and a progressively decreasing force of the pulse-beat, which does not respond to stimulation, death occurring after a few hours.

In patients predisposed to this condition the occurrence of cyanosis not due to spasm of the glottis or bronchorrhœa, especially if associated with a rapid, irregular, and weak pulse, demands the immediate cessation of the anæsthetic and the administration of stimulating measures.

Heat-prostration.

Gibson has called attention to the fact that individuals under general anæsthesia are apparently very susceptible to the prostrating effects of heat. Patients undergoing surgical operations during hot weather, especially if preceded by a long period of fasting, not infrequently exhibit symptoms of profound weakness accompanied by a rapid, feeble pulse, exceedingly high temperature, and mental confusion or delirium. The symptoms sometimes appear immediately after the operation, always within a few hours, and long before septic influences could produce such effects. In a case recently under the observation of the writer the removal of a pharyngeal growth was followed in a few hours by a rise of temperature to 106° F. or above, with a pulse of 160. Both under appropriate treatment gradually fell to normal without evidences of sepsis. In another and fatal instance an easy and short laparotomy was immediately followed by a rise in temperature which in twelve hours reached 109.4° F.

The **treatment** of these cases should be by cold water and stimulation. Placing the patient on a rubber sheet and sprinkling with cold water from an ordinary garden sprinkling-pot, every two or three hours, will often produce a marked improvement in the symptoms.

The Status Lymphaticus.

In a number of cases in which sudden death has occurred as a result of anæsthesia or slight injury in apparently healthy individuals, a condition of hyperplasia of the lymphoid structures throughout the body has been found. The earlier observations associated these deaths with abnormal enlargement of the thymus gland only, and the cause of death was supposed to be asphyxia from pressure on the trachea, a condition which in its less severe form is spoken of as *thymic asthma.* More recent investigations have shown that in these cases there is, in addition, generally an enlargement of the spleen, thyroid gland, lymph-nodes, tonsils, and other lymphoid structures. The condition is associated often with exophthalmic goitre and with rickets.

Clinically the condition is characterized, according to Blake, by "lowered vitality or an unstable equilibrium of the vital forces, so that accidents or disturbances otherwise unimportant, such as some slight injury or an anæsthesia, may precipitate a failure of the heart and respiration."

Death may occur at any stage of the anæsthesia, or after the patient apparently has recovered from its effects.

The **symptoms** are pallor, dyspnœa, rapid or shallow respiration, progressive weakness of the heart, and other evidences of collapse. The condition rarely is recognized clinically before the fatal attack.

Fat-embolism.

As a result of fractures and other traumata which injure and lacerate the fatty tissues, small globules of fat may be taken up by the blood-current and carried to the lungs. If present in sufficiently large amount these fat-globules may plug the pulmonary capillaries and give rise to various disturbances. In certain instances the fat is forced through the lungs and is deposited in the brain, kidneys, and other organs. It was formerly supposed that the fat was directly absorbed by the torn vessels, but as Ribbert has produced the condition experimentally by simple percussion of the tibia, he believes that it is due to a general concussion of the bony skeleton, which liberates fat, chiefly in the bone-marrow, and that these droplets are absorbed by the lymphatics.

Symptoms.—The symptoms of fat-embolism are slight dyspnœa, which may increase and result in cyanosis, restlessness, somnolence, coma, and death. Free fat may be found in the urine. Fever is occasionally present, due in some cases to a secondary pneumonia, in others to a lesion of the heat centre. Marked cardiac weakness may develop from plugging of the coronary arteries. The symptoms rarely begin before the second day.

Spontaneous recovery in mild cases is the rule.

Treatment.—The treatment should consist in rest of the injured part and cardiac stimulants.

Delirium Tremens.

The sudden withdrawal of alcohol in a person addicted to its daily use may result in a state of intense nervousness, loss of sleep, delirium, weird illusions, vivid hallucinations, delusions of persecution, tremor, cardiac weakness, and death. The shock of injury or operation not infrequently acts as an exciting cause in an individual predisposed to this disease by chronic alcoholism. The disease rarely occurs in periodic drinkers, but rather in those who regularly consume a certain amount of alcohol each day. It follows the use of whiskey or other ardent spirits more frequently than wine or beer.

The **symptoms** of delirium tremens are well known and characteristic. After an injury or operation associated with a certain degree of shock, the patient will exhibit symptoms of extreme restlessness, will become irritable in temper, will attempt to get out of bed, and loudly abuse any nurse or attendant who attempts to restrain him. During the night the symptoms become more marked. He has delusions of persecution, sees strange animals, insects, serpents, and other reptiles about him and in his bed. He makes violent efforts to rid himself of these, and loudly calls upon his attendants for assistance. With this there is marked muscular tremor, profuse perspiration, evidences of extreme fright, and of acute mental and physical suffering. There is constant muscular effort to get out of bed or to resist those who are restraining him, with no evidence of pain in the injured part or extremity, which is often used as vigorously in his efforts as the sound members. The exhaustion which follows these efforts may result in syncope and sudden death, or coma may supervene and death follow at a later period.

Prognosis.—The prognosis should be guarded in all cases of traumatic delirium tremens, as the death rate is decidedly higher than when unassociated with injury.

Treatment.—In the treatment of this condition it should be remembered that a liberal use of alcohol after injury or operation is to be advised in those predisposed to delirium tremens. This often acts as a prophylactic measure. Alcohol administered after the symptoms have fully developed has no apparent effect on the duration of the disease. The two most important factors in the treatment of delirium tremens are the early and frequent administration of food and the use of measures to induce sleep. Hot milk or egg-nogg given every two or three hours is to be recommended, also strong broths, beef-juice, tea or coffee.

The best drug to induce sleep is bromide of sodium, but unless given early in the disease it rarely succeeds unless combined with chloral, paraldehyde, or some other powerful hypnotic. In certain cases when patients refuse to swallow, the hypodermic injection of $\frac{1}{4}$ grain of morphine with $\frac{1}{100}$ grain of scopalamine will be found useful, also hyoscin hydrobromate in doses of $\frac{1}{150}$ to $\frac{1}{75}$ grain.

CHAPTER VII.

SURGICAL TECHNIC.

Asepsis and Antisepsis.

Before the discovery of the relationship between micro-organisms and wound infection, and the general acceptance of the germ theory of infectious diseases, little or no effort was made by surgeons to employ more than ordinary cleanliness in their surgical work. The region of the wound rarely was washed, the surgeon generally carried his dressings in his pocket, his needles and sutures in his medicine-case, and washed his hands after rather than before operation. Practically all wounds were infected, fully 90 per cent. suppurated, post-operative pus was supposed to be a normal accompaniment of repair, and the death-rate from pyæmia, septicæmia, tetanus, and erysipelas after severe traumata and surgical operations was very high. The discovery in 1867, by Sir Joseph Lister, of the bacterial cause of wound infection, and the demonstration by him of the results obtained by his new method of wound treatment, inaugurated a reform in surgical technic which was immediately taken up by surgeons in all parts of the world. During the past twenty years these methods have been considerably modified and improved, and have resulted in the modern perfected aseptic and antiseptic technic now almost universally employed by surgeons.

Two methods of wound treatment are in general use at present, the *antiseptic* or germ-killing method and the *aseptic* or germ-excluding method. Both methods have for their object the rendering of the wound sterile or free from pathogenic micro-organisms. The necessity for these methods depends upon the now generally accepted fact that micro-organisms are practically everywhere present; no object can be regarded as free from them until it has been subjected to a process of sterilization. Sterility is something more than cleanliness. A freshly laundered pocket-handkerchief lying in a dainty bureau-drawer may be said to be clean, but it is not sterile, and would not be suitable for a wound dressing until it had been subjected to dry or moist heat at the temperature of 212° F. or above, for half an hour at least, or had been soaked in some strong antiseptic solution. Any subsequent contact with an unsterilized object would immediately destroy its sterility and render it again unfit for a wound dressing.

The *antiseptic method* was first used by Lister, and consists in removing as far as possible pathogenic organisms from the wound of the patient and the hands of the operator and his assistants by vigorous scrubbing with soap and water, and afterward killing the remaining germs or those subsequently introduced into the wound, by the generous employment of solutions of chemical disinfecting agents, as carbolic acid, mercuric chloride, etc. The instruments, sponges, gowns, towels, dressings, etc., are all to be rendered sterile before being brought into contact with the wound area.

This method, formerly universally employed, is now used chiefly in infected cases and in those in which the more perfect aseptic method cannot be successfully carried out.

The *aseptic method* is the more modern, and is a decided improvement over the preceding when it can be perfectly carried out. It does away with the necessity of employing antiseptic agents by insuring absolute sterility of everything which may by any possibility be brought into contact with the wound. It has, however, two weak points, the skin of the patient and the air of the operating-room, neither of which can with certainty be rendered sterile. Practically, however, these factors are of little moment, as infection rarely occurs which cannot be traced to other sources of contamination.

The aseptic method is applicable to all cases in which the wound area is free from infection at the time of operation, when the operator can have the advantage of a well-equipped operating-room and trained assistants. When these cannot be had, or when errors of technic occur, antiseptic measures must also be employed.

The methods of skin disinfection, and the preparation of the instruments, sponges, dressings, gowns, sheets, towels, etc., are the same in both methods, and are as follows :

Preparation of the Patient.—When possible a full bath should be taken the day before the operation, followed by shaving the wound area and as much of the surrounding skin as will be exposed on the table. The part should then be scrubbed with soap and hot water for two minutes, after which a soap poultice should be applied for several hours. The morning of the operation the parts should again be scrubbed with soap and water for from three to five minutes, a sterile towel or mass of fluffed gauze being employed by a nurse or assistant after thorough disinfection of the hands. A wet bichloride dressing (1 : 5000) should then be applied. This should be removed on the operating-table and the part scrubbed for one minute, afterward douched with alcohol, ether, bichloride solution, and sterile water. The wound area should then be surrounded by a sterile sheet or sterile towels which cover all parts of the body and operating-table likely to be touched by the surgeon or his assistants.

Preparation of the Operator, His Assistants, and the Nurses.—All should be clothed in sterile gowns or suits, the head covered with a cap, and the sleeves rolled up above the elbows. The hands and arms should be prepared by scrubbing with soap and frequent changes of hot water for five minutes, a sterile nail-brush being employed. Particular attention should be given to the region of the nails, which should be previously cleansed with a pointed orange-wood stick or other nail-cleaner. After scrubbing for five minutes a paste should be made in the hand by moistening a mixture of equal parts of chlorinated lime and washing-soda with a little hot water. When this becomes slightly warm and free chlorine gas is given off, the paste should be thoroughly rubbed on the hands and arms, and afterward completely removed by bathing in sterile water and mercuric chloride. Freshly boiled rubber gloves should then be drawn on the hands and worn by all participating in the operation. Other chemical agents are employed for hand disinfection, but they are all inferior to the chlorine mixture. These are all to be used after the thorough preliminary scrubbing with soap and water. They are solutions of mercuric chloride, 1 : 1000; solutions of carbolic acid in alcohol and water, 3 per cent.; a saturated solution of potassium permanganate followed by bathing in a saturated solution of oxalic acid, to remove the stain of the permanganate. A 1 per cent. solution of formalin is one of the best hand disinfectants, but is open to the objection that it not infrequently produces a peculiar and obstinate form of dermatitis resembling psoriasis.

Preparation of the Instruments, Silk, Silk-worm gut, Silver Wire, etc.—These are all rendered absolutely sterile by boiling for five minutes in a 1 per cent. solution of sodium carbonate (anthrax and subtilis spores are killed by boiling water in two minutes). The instruments should afterward be transferred to sterile water, as the sodium solution renders them too slippery to be easily held. Knives, scissors, and needles are rendered dull by frequent boiling. These should be sterilized by immersion in pure carbolic acid, afterward rinsing in alcohol and sterile water.

Preparation of Suture and Ligature Material.—The materials used for sutures and ligatures are silk, silk-worm gut, catgut, chromicized catgut, kangaroo-tendon, horse-hair, and silver wire.

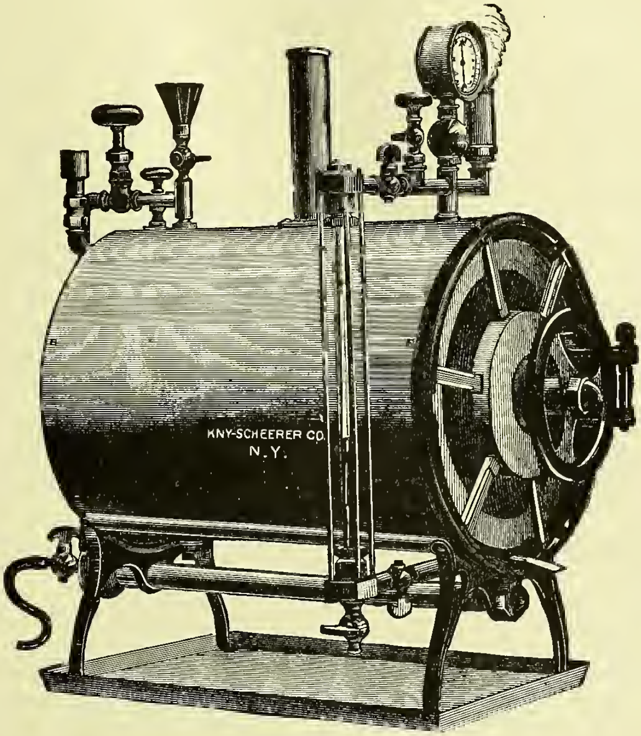
Silk, silk-worm gut, horse-hair, and silver wire may be sterilized by boiling, or by subjecting them to live steam of a temperature of 212° F. or above for one hour. Catgut may be sterilized by the following four methods:

1st. Place the catgut in a glass flask of ether, shake frequently for six hours, then change to a flask of absolute alcohol and shake frequently for six hours, then in a flask of 10 per cent. solution of carbolic acid in absolute alcohol and shake at intervals for six hours more, after which store in absolute alcohol until used.

2d. After treating with ether and alcohol as above, boil in alcohol under pressure for thirty minutes.

3d. Iodine catgut is prepared by Bartlett in the following manner: Cut strands of suitable size and wind into small coils. Suspend the coils in liquid petrolatum heated on a sand-bath to 212° F. for twelve hours, then raised to 300° F., after which the coils are transferred to a solution composed of 1 part of iodine flakes to 100 parts of Columbian spirits.

FIG. 26.



Steam autoclave.

4th. Roosevelt Hospital method: Raw catgut is immersed in the following solution:

℞	Hydrarg. bichlorid,	gr. xv.
	Acid tartaric,	gr. lxxv.
	Ether,	
	Columbian spirits,	āā Oj.—M.

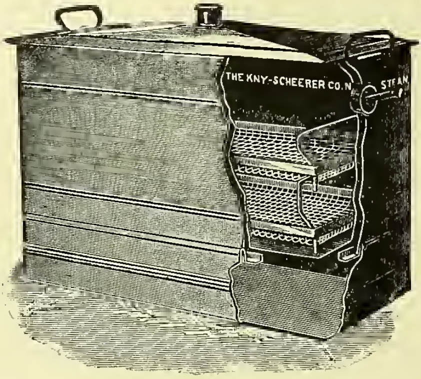
No. 1 should be allowed to remain in the solution six hours, No. 2, eight hours, No. 3, twelve hours, No. 4, sixteen hours, No. 5, twenty hours; after which the catgut is stored in Columbian spirits.

Many other methods are in use, including that by cumol and formalin. Thoroughly reliable catgut can now be obtained in small hermetically sealed glass tubes from any reliable surgical supply house.

Chromicized catgut may be prepared by soaking the catgut in a solution of chromic acid, made by dissolving 30 grains of the crystals in 1 pint of a 5 per cent. aqueous solution of carbolic acid, and allowing it to remain in the solution from six to twenty-four hours, after which it should be wound on a frame and thoroughly dried, and then sterilized by any of the above methods.

Preparation of Gauze Dressings and Sponges, Cotton, Gowns, Sheets, Towels, etc.—Generally these are sterilized by live steam or dry heat. When possible, one of the modern steam autoclaves should be used (Fig. 26). By means of this they may be subjected to live steam under pressure for any length of time. It has been abundantly proved that subjecting materials of this kind to live steam under a pressure of fifteen pounds for one hour will destroy not only all pathogenic organisms, but their spores as well, rendering the material absolutely sterile. By means of the Arnold sterilizer (Fig. 27) dressings may be subjected to the action of live steam, but not under pressure. This kills the fully developed pus-producing bacteria, but not the spores. Practically, material prepared in this way answers every purpose as well as if sterilized. A satisfactory sterilizer may easily be made out of an ordinary wash-boiler. Take two bricks, place them in the bottom of the boiler, pour in about two quarts of water, and then cover the bricks by two or three long strips of thin board laid lengthwise. On these place the various bundles of sheets, towels, gowns, bandages, dressings, etc., to be sterilized. Put the cover on the wash-boiler and place it on the kitchen range for thirty minutes, after which the materials will be ready for use. When this cannot be obtained, freshly laundered sheets, which are practically free from germs, or clean towels soaked in bichloride solution

Fig. 27.



Arnold sterilizer.

(1 : 1000), can be used, and the sponges and dressings can be boiled for two minutes and allowed to cool before using. All of these materials properly sterilized can now be obtained in sealed packages from reliable supply houses.

Marine sponges are rarely used in aseptic surgery on account of the difficulty in their sterilization. They should be freed from sand and dust, bleached, and kept in a 1 : 20 solution of carbolic acid for several weeks.

All **instrument-trays, sponge basins,** and other **glassware** should be kept scrupulously clean, sterilized in a large steam sterilizer, or immersed in a large tub of bichloride (1 : 1000) for thirty minutes, and afterward rinsed in sterile water.

Irrigating solutions should be made with distilled or boiled water. Normal salt solution may be made by dissolving 100 grains of chemically pure sodium chloride in 32 ounces of water and boiling for two minutes. If it is to be used for intravenous infusion, it should be filtered.

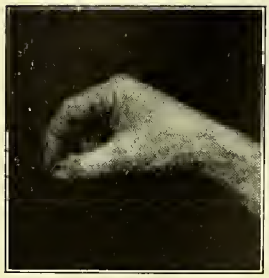
General Management of an Operating-room.—While each surgeon should arrange the duties of his assistants and the general details of his operative technic to suit his own ideas and purposes, a few general rules should be observed in all well-regulated operating plants.

The operating staff of a large general hospital should consist, in addition to the operating surgeon, of two sterile assistants and two sterile nurses. In addition to these there should be one or two extra attendants, nurses or orderlies, to assist in moving the patient, to regulate the position of the operating table, handle the electric lights, cautery, irrigating cans, etc., and to assist the anæsthetist.

The first assistant should stand opposite the operator, sponge and clamp vessels; the second assistant should handle the retractors; the chief operating nurse should have charge of the instrument tray, the ligature and suture material; the assistant nurse should handle the sponges, towels, sheets, and pads. Each assistant should thoroughly understand his or her duties and should follow the operator and anticipate his wants. As far as possible, talking should be avoided by those participating in the operation, as it has been repeatedly demonstrated that infection may occur by contamination of the wound area by minute quantities of mucus or saliva from the mouths of talking operators or assistants.

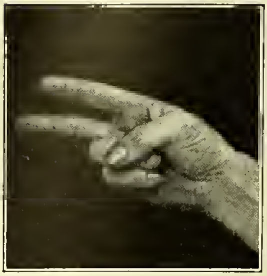
In operating with new assistants or when, for any other reason, spoken directions are frequently necessary, face masks of gauze should be worn. Some years ago the writer adopted a sign language by means of which he was able to abolish practically all conversation during the progress of any of the ordinary routine operations (Figs. 28 to 45).

FIG. 28.



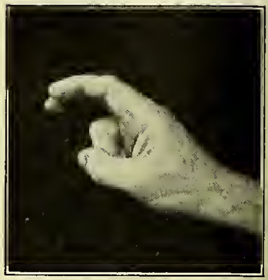
Knife. Position of fingers in holding a knife with slight downward motion of hand, as in making an incision.

FIG. 29.



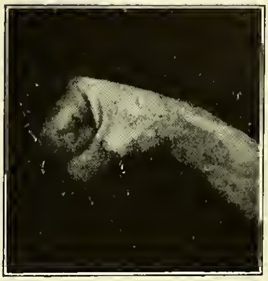
Straight Scissors. Scissors-like motion with index- and middle fingers.

FIG. 30.



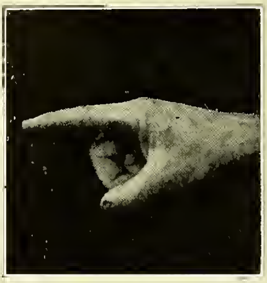
Curved Scissors. Same with curved fingers.

FIG. 31.



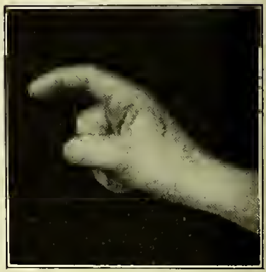
Sponge. Closing fingers as in grasping a sponge.

FIG. 32.



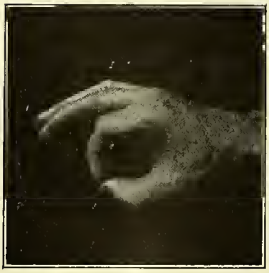
Straight Needle.

FIG. 33.



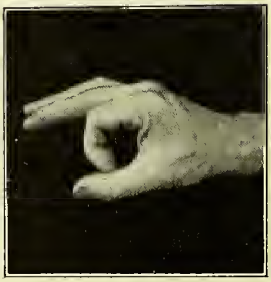
Curved Needle.

FIG. 34.



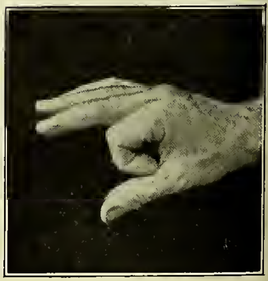
Large.

FIG. 35.



Medium.

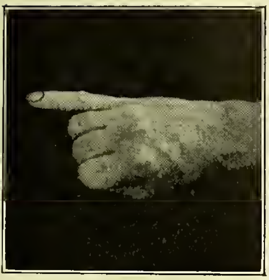
FIG. 36.



Small.

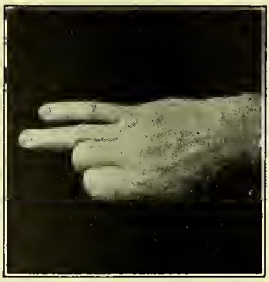
SIGN-CODE FOR OPERATIONS.

FIG. 37.



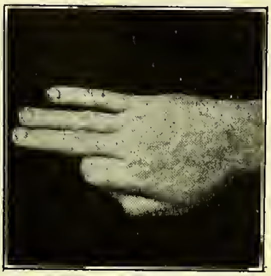
Silk.

FIG. 38.



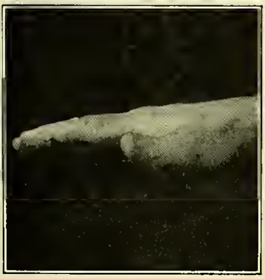
Silkworm Gut

FIG. 39.



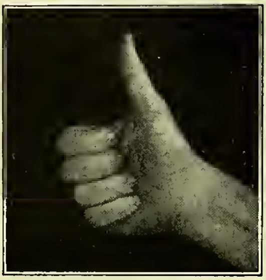
Chromic Gut.

FIG. 40.



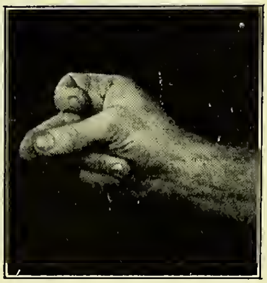
Towel. With lateral motion of hand as in spreading a towel.

FIG. 41.



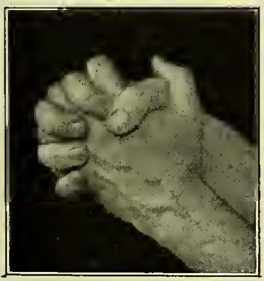
Abdominal Pad.

FIG. 42.



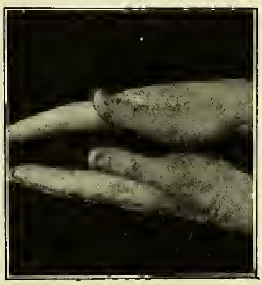
Ligature. Snapping fingers once for small size, twice tor medium, three times for heavy.

FIG. 43.



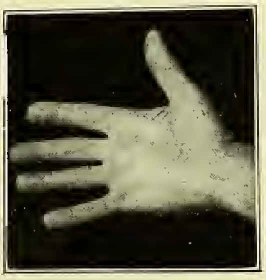
Handkerchief Gauze Packing.

FIG. 44.



Dressing.

FIG. 45.



Saw.

SIGN-CODE FOR OPERATIONS.

Good team work on the part of the operator and assistants is the essential factor in perfect operating-room technic. Loud talking and angry criticism on the part of an operator generally defeats his object by rendering the assistants nervous and hasty in their various duties, which, in turn, always favors the occurrence of technical errors.

The rough handling of the tissues, the tearing apart of anatomic structures, bruising the wound edges by forcible retraction, and the inclusion of large masses of tissue in hæmostatic ligatures are to be avoided as favoring infection. Other things being equal, the best results will be obtained by the surgeon who performs his operation in the shortest time and with the minimum of exposure and trauma to the tissues.

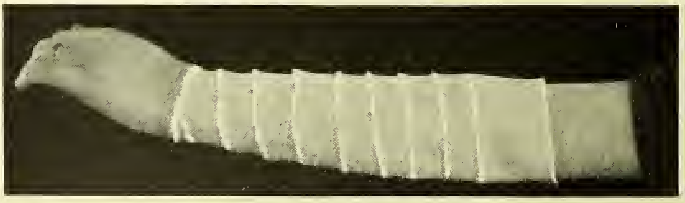
Post-operative rest, both physical and mental, are of importance, and contribute much to the rapidity of convalescence. Pain should be relieved by changes in position, hot or cold applications, and anodynes when necessary. Persistent vomiting should be treated by gastric lavage, and the patient's fears and anxieties should be relieved by reassuring words of encouragement from the surgeon.

Bandaging.

Bandages are used in surgery chiefly to hold in place surgical dressings and splints; they are also employed to exert pressure on certain parts and thereby to relieve congestion, to promote absorption of extravasated fluids or exudates, to prevent œdema, to support weak-walled vessels, as well as to give protection and support to injured limbs and joints.

The materials used for bandages are gauze, muslin, crinolin, rubber, flannel, canton-flannel, and fabrics impregnated with plaster-of-Paris, starch, dextrin, and other hardening substances. For holding dressings in place, the muslin or gauze bandage is commonly employed; for supporting varicose veins, applying pressure to a limb or joint, the rubber or flannel bandage is used; while to insure fixation of a broken limb or injured joint, the plaster-of-Paris, starch, or dextrin bandage is to be recommended.

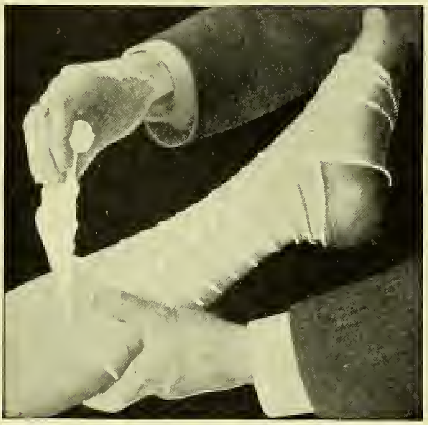
FIG. 46.



Ascending spiral bandage. (Wharton.)

Methods of Applying the Roller Bandage.—If the part to be bandaged is of even size throughout, as the upper arm or trunk, the free end of the bandage is laid upon the part and held in place by the left hand, while the roller is carried by the right hand around the part to be bandaged in such a way that the second turn will hold the first firmly in place. Each revolution of the bandage covers at least one-half of the last turn. When the upper limit of the bandage is reached, the end is pinned to the layer beneath (Fig. 46). If the part to be bandaged is conical, as the leg or forearm, the *spiral reversed* bandage is applied, in which each turn is made to fit snugly to the limb by being turned upon itself, as seen in Fig. 47; or the *figure-of-eight* bandage is employed, in which the lower loops of bandage are snugly and evenly adapted to the limb, and as the bandage ascends they eventually cover the

FIG. 47.



Method of making reverses. (Wharton.)

FIG. 48.

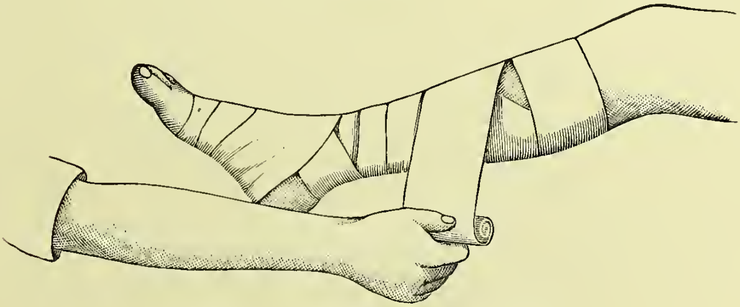
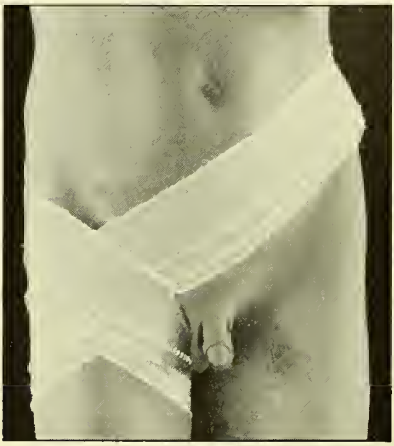


Figure-of-eight bandage of leg. (Park.)

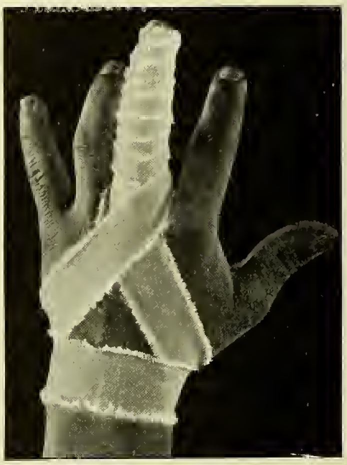
more loosely applied upper loops (Fig. 48). In applying a bandage to the groin or shoulder, the *spica* is employed, beginning on the limb and making a figure-of-eight around the limb and trunk, as seen in Fig. 49. In bandaging the thumb or one of the fingers, the free extremity is covered with the spiral reversed; and when the base is reached the spica is used, the upper loop of which encircles the digit and the lower loop the hand and wrist (Fig. 50). In bandaging the knee, the figure-of-eight is used, the first turn being taken around the joint opposite the middle of the

Fig. 49.



Ascending spica bandage of the groin. (Wharton.)

Fig. 50.



Spiral bandage of the finger. (Wharton.)

Fig. 51.

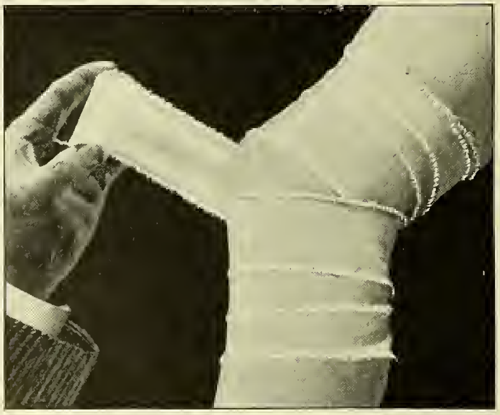
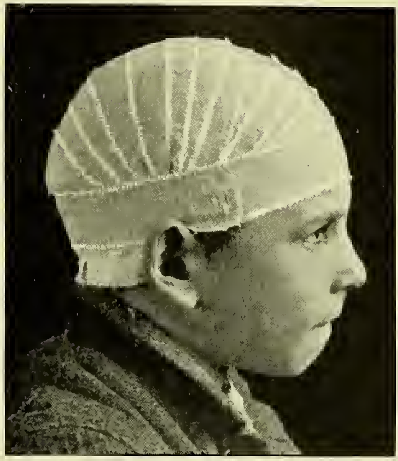


Figure-of-eight bandage of the knee. (Wharton.)

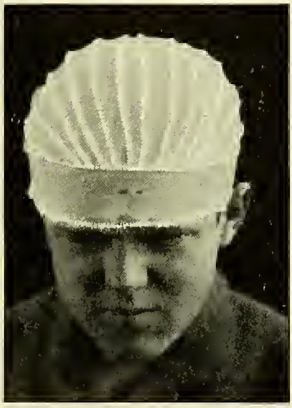
patella, after which the loops alternate, one being applied above and the next below the first turn (Fig. 51). In bandaging the head, one or two loops are made to encircle the head, passing from the frontal region just above the eyes around the occipital protuberance; a figure-of-eight bandage is then applied in a transverse direction, beginning just above one ear and carrying the first turn over the centre of the vault to the opposite ear; then a number of turns are taken between these two points alternately in front of and behind the first until the entire vault is covered. The loops made by reversing the bandage just above each ear are

FIG. 52.



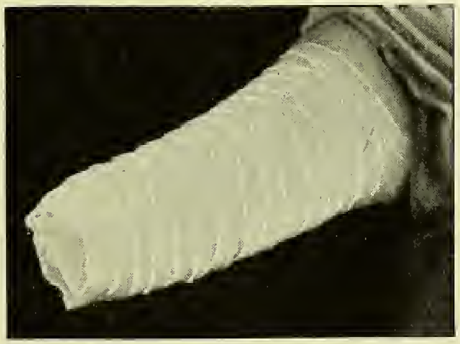
Transverse recurrent bandage of the head. (Wharton.)

FIG. 53.



Recurrent bandage of the head. (Wharton.)

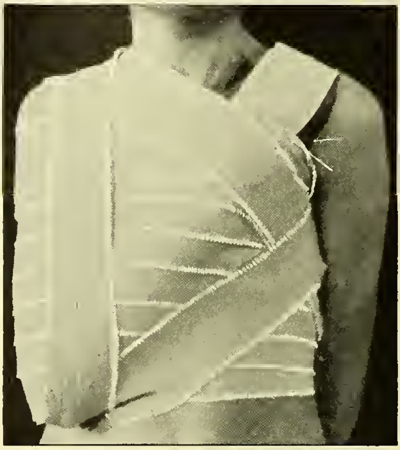
FIG. 54.



Recurrent bandage of a stump. (Wharton.)

firmly held until all the transverse turns are made, and finally secured by three or four encircling turns around the forehead and occiput, safety-pins being finally introduced to hold all in place (Fig. 52). The folds covering the vault may also be made longitudinally if desired (Fig. 53).

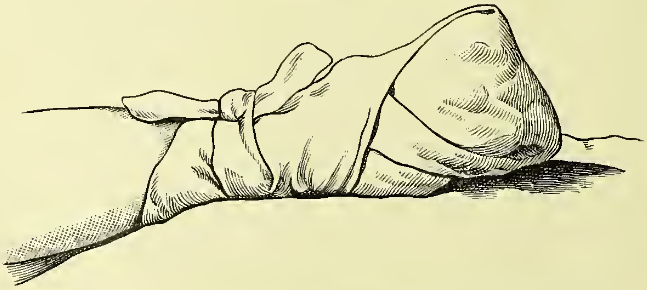
FIG. 55.



Modified Velpeau dressing. (Wharton.)

In bandaging an amputation-stump, make one or two circular turns around the circumference of the stump, then a number of turns at a right angle to these, inclosing the extremity, and holding these in place by a circular or reversed spiral from the extremity upward until a joint or some bony protuberance is covered to hold it in place (Fig. 54).

FIG. 56.

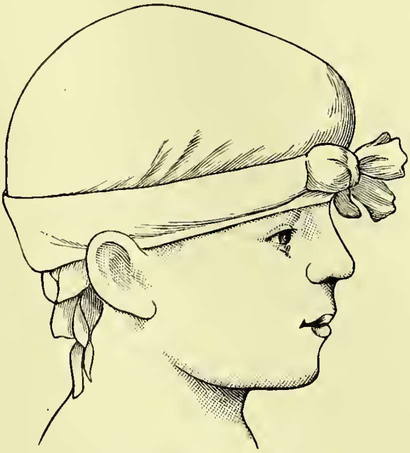


Handkerchief bandage of foot.

The Velpeau Bandage, for Holding the Arm Securely to

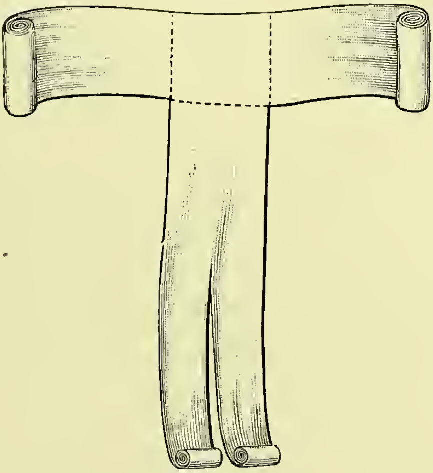
the Chest-wall.—Place the hand on the opposite shoulder. Take two or three turns of a wide roller bandage around the thorax, including the arm; then pass the bandage from the free axilla behind to the fixed shoulder, passing over this shoulder from behind forward; carry the bandage around the point of the elbow and then upward behind the same shoulder over its summit down-

FIG. 57.



Handkerchief bandage of head.

FIG. 58.



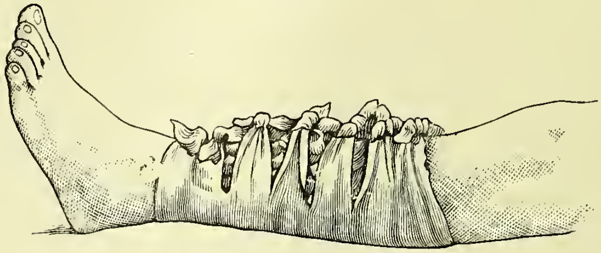
T-bandage.

ward in front to the free axilla, then circularly around the chest, alternating these turns until the entire arm and chest are included (Fig. 55).

All of these methods may be modified to meet special indications.

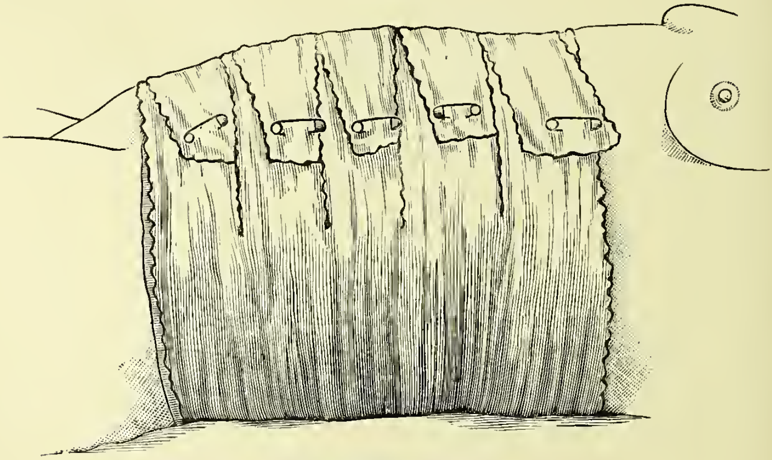
The **triangular** or **folded handkerchief bandage** is made by folding a square piece of muslin or gauze into a triangle. This can be applied over a bulky dressing of the hand or amputation-stump by placing the base of the triangle at right angles to the limb and folding the apex over its extremity, and securing it by wrapping the two extremities of the base snugly around the limb and tying them (Fig. 56). This bandage may also be employed on the head (Fig. 57).

Fig. 59.



Many-tailed bandage of leg.

Fig. 60.

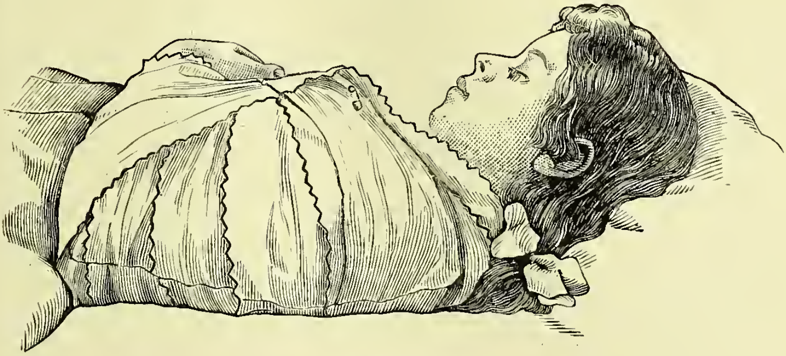


Many-tailed bandage of abdomen.

The **T-bandage** is used for dressings applied to the perineum, the horizontal arms encircling the trunk, the perpendicular arm passing between the thighs from behind upward and fastened to the front of the body portion (Fig. 58).

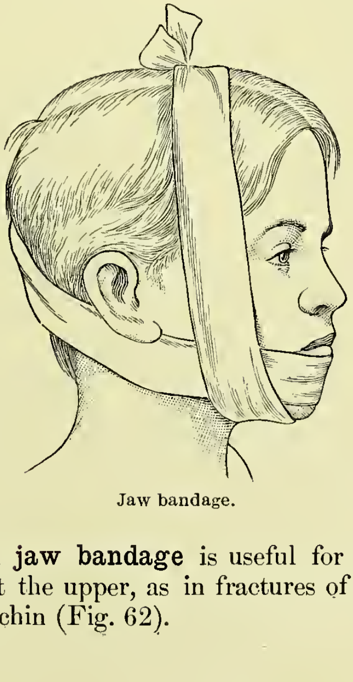
The **many-tailed bandage** is useful for almost any part where dressings are frequently changed (Fig. 59). It is particularly serviceable when a firm abdominal binder is required (Fig. 60) and in breast amputations (Fig. 61).

FIG. 61.



Breast-binder.

FIG. 62.

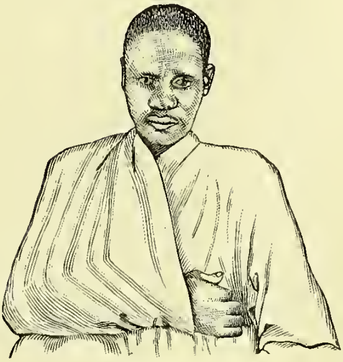


Jaw bandage.

The **two-tailed jaw bandage** is useful for holding the lower jaw firmly against the upper, as in fractures of the lower jaw or in wounds of the chin (Fig. 62).

The **sling**, to support the forearm and arm, is made by folding a large piece of muslin into a triangle. Place the two extremities of the base-line around the neck and allow the forearm to rest in the loop (Fig. 63).

FIG. 63.



Triangular sling.

The Sling and Chest-binder.—This is a very useful bandage for fixing the arm to the chest, and is used in fractures of the clavicle and humerus, injuries to the shoulder and elbow. Place one extremity of a triangular sling in place around the neck, flex the elbow and place the forearm across the chest, then apply a chest-binder including the upper arm, and fix with safety-pins, after which the other extremity of the sling is folded around the forearm and carried upward around the neck

FIG. 64.

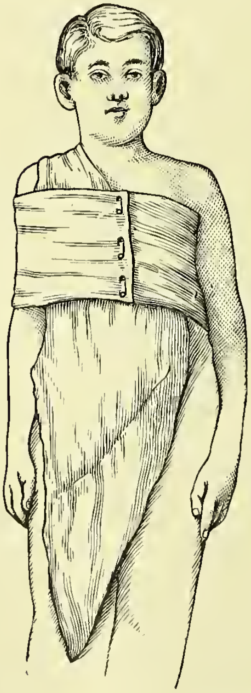
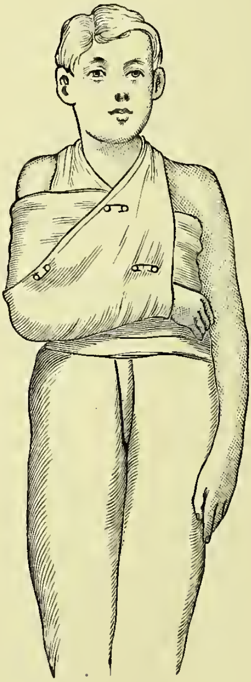


FIG. 65.



Sling and chest-binder.

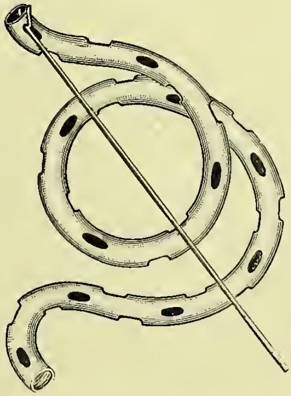
and tied to the one already in place; fasten all these layers together with safety-pins (Figs. 64 and 65).

Plaster-of-Paris bandages are used whenever a fixed stiff dressing is required for protection or to limit mobility. They are made by rubbing plaster-of-Paris into the meshes of a gauze or crinoline bandage. The part should first be covered with a layer of sheet wadding, cotton, or lint. The plaster bandages are then placed in a basin of warm water to which a teaspoonful of common salt has been added. When the bandage is thoroughly soaked, it should be squeezed as dry as possible and applied over the layer of wadding. Care should be taken to apply the layers evenly, and in general the figure-of-eight should be used on a conical part rather than the reversed spiral, as the wet bandage when reversed is apt to roll itself into a hard cord, which may produce subsequent discomfort. Good plaster will set or harden in a few minutes. These dressings are removed by cutting or sawing through the plaster down the front or along one side. In thick casts this is often difficult, and can be made easier by moistening with a strong solution of mercuric chloride or dilute hydrochloric acid.

Wound Dressings.

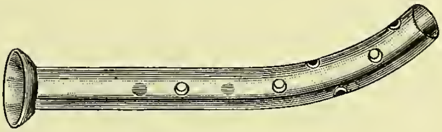
Clean, freshly made wounds are best dressed with sterile dry gauze, which is simply held in place by a bandage. The dressing should be large enough to extend well beyond the wound-limits, and secured firmly enough to prevent being displaced and exposing any part of the wound. The use of thin silver foil next to the wound or a layer of gauze wet with a 1 : 100 solution of formalin will serve to prevent stitch infection from Staphylococcus epidermidis albus. If there is reason to suppose that the wound is infected, provision should be made for drainage by leaving the wound partly open, by packing with gauze, by the introduction of a rubber drainage-tube (Fig. 66), or by the use of a thin strip of folded

FIG. 66.



Rubber drainage-tube.

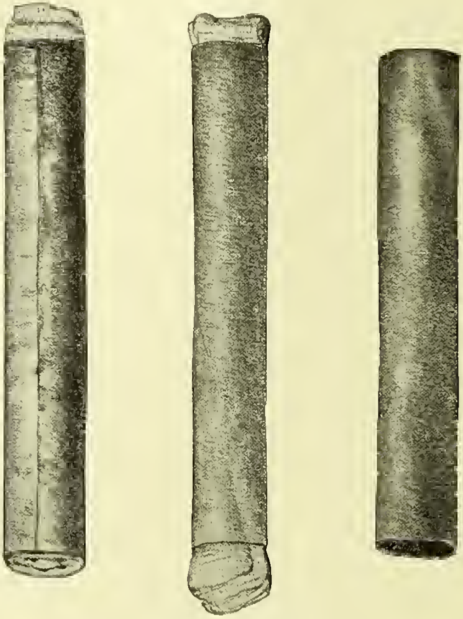
FIG. 67.



Glass drainage-tube.

sterile rubber protective tissue. If the wound is a deep one, or in one of the body cavities, or if an abundant fluid discharge is expected, a glass drainage-tube may be employed (Fig. 67), or, especially in the abdominal cavity, the *cigarette drain* will be found useful. This consists in a roll of gauze covered by thin rubber tubing or rubber protective tissue (Fig. 68).

Fig. 68.



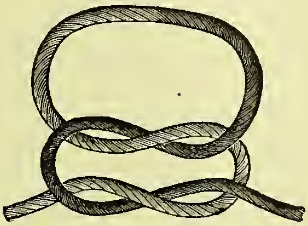
Cigarette drains.

Infected or open wounds are often treated by **wet dressings.** Several layers of gauze are wet with some antiseptic solution and placed next to the wound; this is covered with oiled silk or rubber tissue to prevent too rapid evaporation, and held in place by a roller or many-tailed bandage. Wet dressings should be frequently opened and more of the solution added. Of the solutions most used, mercuric chloride, 1 : 5000 to 1 : 1000; aluminium acetate (1 part of alum, 25 parts of lead acetate, and 500 parts of water); carbolic acid, 1 : 500 to 1 : 100; Thiersch's solution, made by dissolving 1 part of boric acid and 6 parts of salicylic acid in 500 parts of water; and myrrh wash, made by adding 1 part of tincture of myrrh to 12 parts of water. The latter is very useful in foul suppurating wounds. Abscess-cavities and long suppurating sinuses should be dressed once or twice daily, irrigated with some antiseptic solution, and allowed to heal from the bottom. Such cavities, if indolent, should be packed with gauze soaked in balsam of Peru or "red wash," which is a mixture of 2 parts of zinc sulphate and 100 parts of tincture of lavender in 500 parts of water.

Ligatures.

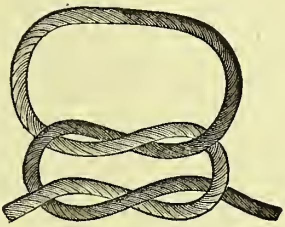
Wounded vessels should be clamped and ligated. If possible, an absorbable ligature should be used. Sterile catgut is the material to be recommended, the smaller sizes for small vessels, larger sizes for medium sized vessels, and medium or heavy chromicized catgut for the larger arteries. When sterile catgut cannot be had, silk should be used. If neither can be obtained, ordinary linen thread boiled for ten minutes will answer the purpose. The reef or square knot (Fig. 69), the granny knot (Fig. 70), and the surgeon's knot (Fig. 71) are the ones generally employed. The Ballance and Edmunds knot is highly recommended in the ligature of large arteries. Two strands of floss silk are passed around the vessel and the first half of a knot tied in each separately; then both strands are taken together and the last half of the knot tied as one.

FIG. 69.



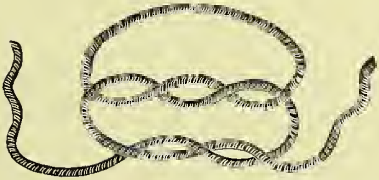
Reef or flat knot.

FIG. 70.



Granny knot.

FIG. 71.

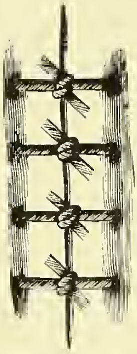


Surgeon's knot.

Methods of Wound Closure.

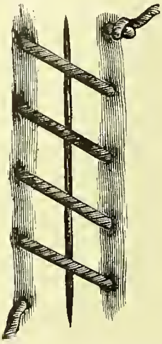
If the wound is superficial, aseptic, and there is no tension, the divided edges of the skin can be approximated and held by a few interrupted sutures (Fig. 72), care being taken that the edges of the wound are in exact apposition, and not folded inward by drawing the suture too tight. Tight suturing also favors marginal necrosis and infection by interfering with the circulation. Silk, silk-worm gut, horse-hair, and silver wire are to be preferred to catgut for cutaneous sutures, for the reason that catgut swells, seals the minute opening through which it passes and thus prevents capillary drainage. The continuous suture is largely employed in closing cutaneous wounds (Fig. 73), also the locked stitch (Fig. 74) or the mattress suture (Fig. 75). The continuous mattress suture, or Cushing suture, is employed by many in intestinal work (Fig. 76). When considerable force is needed to bring the wound edges together, a few deep sutures introduced at

FIG. 72.



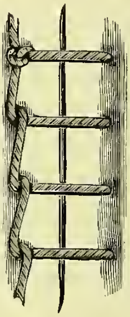
Interrupted suture. (Park.)

FIG. 73.



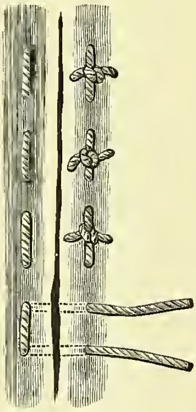
Continued suture. (Park.)

FIG. 74.



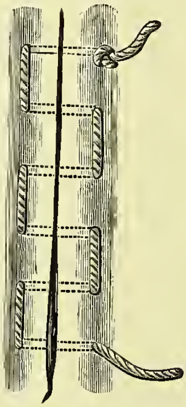
Chain-stitch suture.

FIG. 75.



Mattress suture, interrupted.

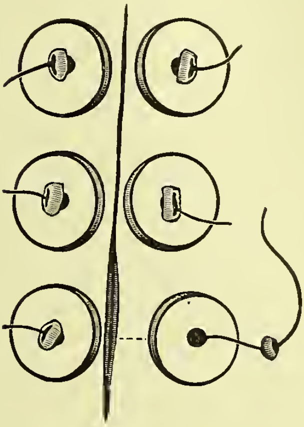
FIG. 76.



Cushing suture.

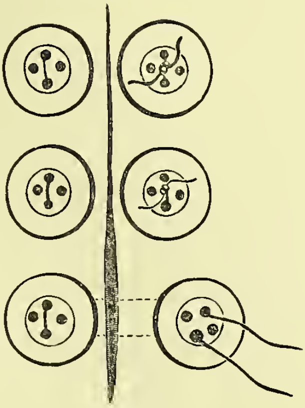
some distance from the wound-margin relieve the tension on the cutaneous sutures. Strong silk or silk-worm gut is the best material for the purpose, and fastening each end to a button, lead plate, or quill will often prevent them from tearing through the tissues (Figs. 77, 78, 79).

FIG. 77.



Lead plate suture.

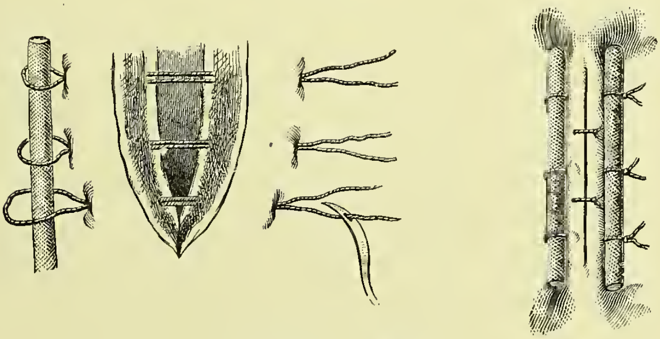
FIG. 78.



Button suture.

In *deep wounds* and *amputation-stumps* it is often desirable to bring the muscles and fascial layers together to avoid dead spaces, which allow accumulation of blood and other fluids and favor infection. This is accomplished best by the introduction of a few deep catgut sutures. In closing *abdominal wounds* it is desirable to unite the different structures separately, in order to prevent a subsequent hernia; the peritoneum should be drawn together with

FIG. 79.

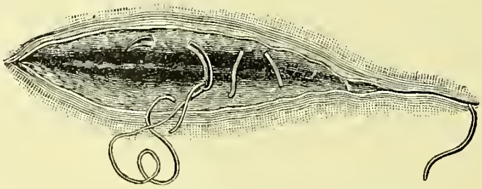


Quilled suture. (Smith.)

a continuous suture of catgut, the muscular and aponeurotic layers with chromicized catgut, and the skin with silk or silk-worm gut. Many surgeons employ the *through-and-through suture* of silk-worm gut or silver wire, including all layers. In the upper zone of the abdomen this method may be employed, as hernias rarely occur in this region. It is to be advised also whenever the condition of the patient demands a speedy termination of the operation, as it requires much less time than layer suture.

The *subcuticular suture* has been extensively employed of late to avoid stitch infection and to render the scar-line less noticeable. It consists in the use of fine silver wire with a full-curved Hagadorn needle. The needle pierces the skin just beyond one extremity of the wound and emerges just within the cut below the cutis. From this point the needle is passed through the subcuticular tissues first on one side and then on the other until the opposite extremity is reached, when the needle again pierces the healthy skin just beyond the wound angle (Fig. 80). When the wire is drawn tight the two edges of the wound are approximated. Experience has shown, however, that these scars eventually become as wide as the others, and also that stitch infection can practically always be prevented by the use of silver foil or formalin gauze over the cutaneous wound.

FIG. 80.



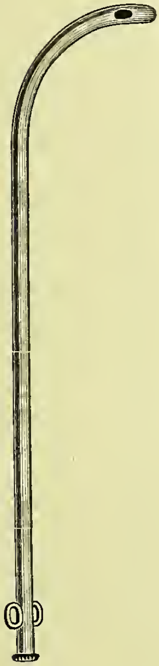
Subcuticular suture. (Wharton.)

Cutaneous approximation without sutures by means of strips of sterilized zinc oxide adhesive plaster, suggested by Lilienthal, has recently come into frequent use. The advantages are that ample drainage space is provided, the skin is not pierced, strangulation of the marginal tissue is avoided, and the chances of infection greatly reduced.

Catheterization.

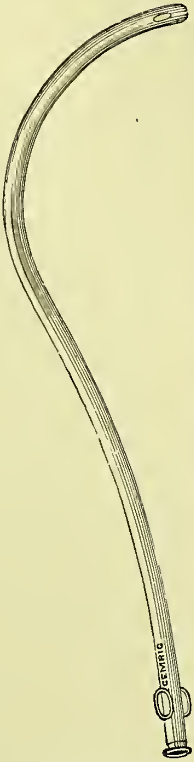
Catheterization, or the introduction of urethral instruments, in the female is generally easy. If a soft-rubber catheter is employed, the tip is well lubricated with sterilized vaselin, or lubochondrine, and introduced within the external meatus, after which the catheter is easily passed into the bladder. If a silver or glass instrument is used, it should be introduced with the curved tip pointing upward. Catheters can be introduced into the female bladder without exposing the patient by first locating the external urethral orifice by the forefinger of the right hand, which can be felt as a puckered depression half-an-inch above the vaginal opening, then passing a glass or gum-elastic catheter along the forefinger into the urethra. In the male catheterization is more difficult owing to the length of the urethra, its subpubic curve, and the fact that the curved portion of the canal is fixed by strong ligamentous structures. The subpubic curve in the adult male urethra corresponds to an arc of a circle three and one-quarter inches in diameter; all solid urethral instruments, therefore,

Fig. 81.



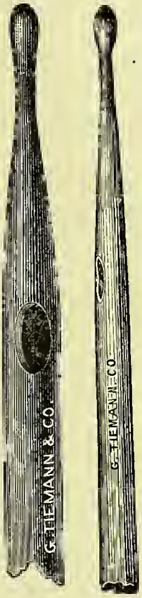
Metallic catheter.

Fig. 82.



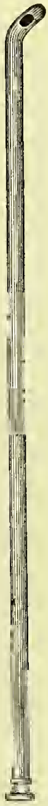
Prostatic catheter.

Fig. 83.



Flexible catheters.

Fig. 84.



Mercier's coudé catheter.

should have a curve corresponding with this. As in the female, soft-rubber and gum-elastic catheters or bougies are easily introduced into the normal male urethra and bladder by simple pressure, the penis being held at a right angle to the body. In introducing a solid silver catheter (Fig. 81) or sound, the surgeon should stand on the patient's left, the penis should be grasped by the forefinger and thumb of the left hand and drawn upward on the abdomen; the instrument, well lubricated, should be held in the right hand, the shaft being parallel with Poupart's ligament. As the sound glides into the canal the shaft should gradually be carried toward the median line and elevated, and when the point of the sound reaches the prostatic portion the shaft should be exactly in the median line of the body and at a right angle with it. Firm pressure should then be made by the right hand over the root of the penis, and with the left the handle should be gently depressed between the thighs. This allows the beak to follow the natural curve of the urethra and to pass into the bladder. If the calibre of the urethra is narrowed or deviated by stricture, periurethral exudate, or enlargement of the prostate, the flexible gum-elastic olivary, coudé or long prostatic catheter should be used (Figs. 82–84). All urethral instruments should be sterilized before introduction, and the region of the meatus disinfected by careful wiping with a pledget of cotton wet with a 1 : 1000 solution of mercuric chloride. Glass, metal, and soft-rubber catheters should be sterilized by boiling; gum-elastic or silk catheters by immersion in a solution of bichloride of mercury or by formalin vapor. If the urethral mucous membrane is infected, it should be irrigated with bichloride solution (1 : 10,000) or potassium permanganate (1 : 4000).

Direct Transfusion of Blood.

The direct transfusion of blood from one individual to another is indicated in cases of severe hemorrhage, grave secondary anæmia, severe toxæmia from sepsis, gas poisoning or acid intoxication, hæmophilia, congenital melena, chronic icterus, and other conditions associated with lessened coagulability of the blood. It is also indicated to improve the physical condition of a debilitated patient about to undergo a surgical operation. It may also be of value to increase the normal resistance of an individual in certain cases of sarcoma or other malignant processes, or to render him immune to certain infectious diseases.

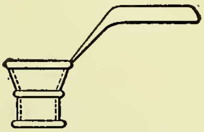
While the advantages of direct transfusion of blood have been recognized for centuries, and various more or less ingenious instruments have been devised to accomplish this end, the operation has been practically abandoned by surgeons for the reason that it rarely succeeded, and in not a few instances disastrous results followed their attempts.

The chief reason for failure was that in the older methods an attempt was made to pass the blood of the donor through a rubber, glass, or metal tube to the veins of the recipient. This almost invariably resulted in clotting, which quickly obstructed the flow.

The demonstration by Carrel that clotting could be eliminated by end-to-end suture of vessels in such manner that intima was brought into direct contact with intima, paved the way for a more rational technic.

Crile, who has given more attention to the subject than any other American surgeon, has devised a simple canula (Fig. 85), having a slightly conical hollow point with two grooves on the outer surface. A short handle projects from one side of the canula, by which it is held.

FIG. 85.



Crile's Transfusion Canula × 2.

The technic of the operation is as follows:

The recipient and donor are placed on two tables and their arms prepared in the usual manner. Under cocaine anæsthesia the radial artery of the donor is exposed for about two inches and ligated at its distal extremity. A temporary clamp is next placed on its proximal end and the artery divided near the ligature. The redundant layer of adventitia is drawn downward and cut off, and the vessel threaded through the lumen in the canula. The lumen of the vessel is then grasped by thin equadistant mosquito forceps and drawn backward over the distal end of the canula, forming an inverted cuff with intima outward. This is held in place by a ligature of fine silk placed over the second groove. The vein of the donor is prepared in the same manner, its lumen expanded by three small clamps, and drawn over the inverted arterial cuff on the canula. The two are secured in place by a second ligature placed over the first groove, which securely holds the two vessels in contact. The temporary clamps are next removed and the blood allowed to flow into the vein of the recipient. The flow at first is often slow, owing to the contraction of the artery from exposure. The application of wet compresses at a temperature of from 108° to 112° F. will generally bring about relaxation of the arterial walls, and a vigorous flow of blood follows, which causes marked pulsations in the vein.

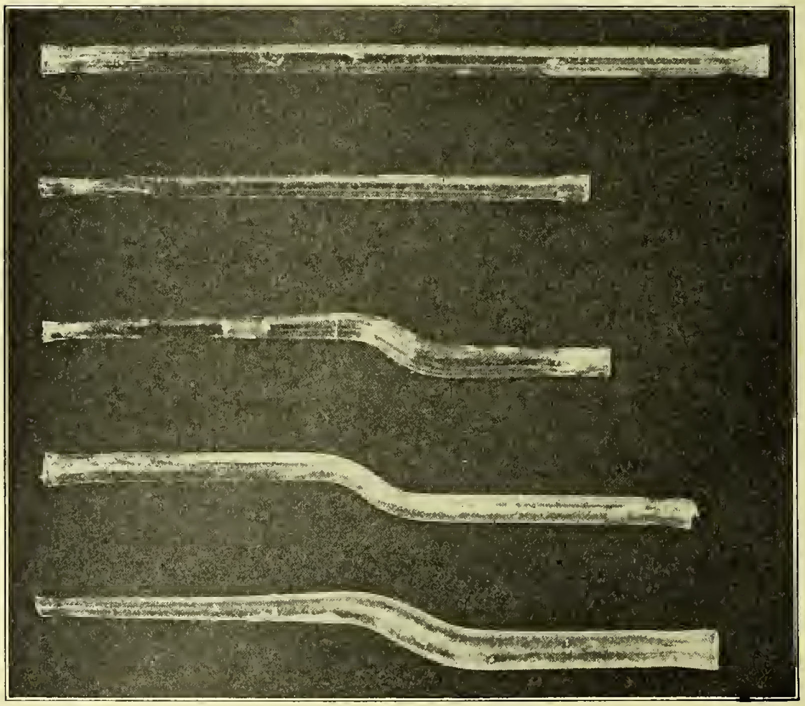
The above technic, while not particularly difficult to one who has had an opportunity of rehearsing the operation either upon an animal or the cadaver, is often attended by certain embarrassments, especially in young children.

With a view to accomplishing the result by some simpler method, the writer undertook a series of experiments upon dogs with glass tubes. It was found that if a glass tube was sterilized, dipped in melted paraffine, and then allowed to cool, the thin layer of paraffine which adhered to its inner surface would effectually prevent coagulation when the tube was used to transmit blood from one animal to another.

In a number of experiments tried, in no case was the blood-current interrupted by clotting, and in no case was any untoward symptom observed in the transfused dogs.

Figure 86 will show the size and shape of the tubes used.

FIG. 86.



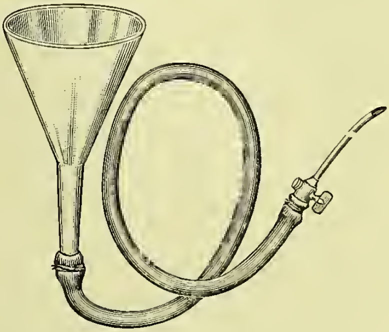
Author's glass canulæ for direct transfusion, showing paraffine coating on inner surface.

The technic of this operation is simple, and consists in exposing the radial artery, dividing it, drawing the proximal end over one extremity of the glass tube and securing it by a silk ligature, then introducing the opposite end of the tube into the proximal end of a divided vein and securing it in the same manner. As soon as the temporary clamps are removed from the vessels, blood is readily tranfused from one individual to the other.

Intravenous Infusion of Normal Salt Solution.

Intravenous infusion of normal salt solution has advantages over all other means of rapidly increasing the circulating medium. It is accomplished by means of an irrigating jar or funnel, a rubber tube, and metal canula (Fig. 87). Any superficial vein of sufficient size to receive the canula will answer. Usually the median cephalic or basilic vein is chosen. This is exposed by a short incision, cleared, and ligated. Above the point of ligature an incision is made into the vessel, the canula introduced and held by a second ligature. From 1 to 5 pints of normal sterile salt solution at a temperature of from 110° to 118° F. may be slowly introduced according to the necessities of the case. Care should be taken that the tube and canula are filled with the solution before the canula is introduced, to avoid entrance of air. In an emergency a satisfactory infusion apparatus may be made from an ordinary tin or glass funnel, a piece of rubber tubing, and a glass eye-dropper. Normal salt solution can be made by adding 130 grains of chemically pure sodium chloride to 1 quart of sterile water. Roswell Park prefers the so-called "balanced physiologic solution," made by adding small quantities of potassium and calcium chloride.[1] Park also advises the addition of small quantities of glucose to the solution if for any reason it is desirable to administer some form of nourishment.

Fig. 87.



Funnel and tube for intravenous injection.

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[1] Park's formula is as follows: Sodium chloride, .09; potassium chloride, .03; calcium chloride, .02; sterile water, 100.

Hypodermoclysis.

Large amounts of fluid may be added to the circulation by introducing salt solution into the subcutaneous connective tissue. This is easily accomplished by an irrigator, tube, and large aspirating-needle. After sterilization of the apparatus and skin of the patient the needle is introduced beneath the skin of the abdomen, thorax, thigh, or buttock, and from 1 to 2 pints of normal salt solution allowed to infiltrate the tissues. This is rapidly absorbed, and the result though slower is often satisfactory.

The same result may often be accomplished by prolonged irrigation of the rectum and colon by means of the Kemp tube.

CHAPTER VIII.

ANÆSTHESIA.

THE term anæsthesia signifies a condition of insensibility to pain. An anæsthetic is any agent which induces this condition. Anæsthetics are divided into *general anæsthetics* and *local anæsthetics:* the former when administered producing insensibility to pain over the entire body accompanied by loss of consciousness; the latter producing insensibility only over the region of their application and being unaccompanied by suspended consciousness. General anæsthesia may be produced by inhalation of the vapor of ether, chloroform, nitrous oxide, ethyl chloride, or ethyl bromide; local anæsthesia may be induced by the effects of cold and by certain drugs, as cocaïne, eucaine, tropacocaine, etc. Previous to the discovery of ether and chloroform, the only means which surgeons possessed to mitigate the sufferings of patients was the local application of cold and the administration of opium and alcohol. The sufferings experienced by those who were obliged to undergo surgical operations limited the employment of the art to cases of dire necessity, and led surgeons in their operative procedures to sacrifice everything to speed. The discovery, however, in 1847, of ether by Morton, and of chloroform the following year by Sir James Simpson, led to a complete revolution in surgical procedure. When it was appreciated that by the use of these agents complete insensibility to pain could be safely produced and maintained during a protracted surgical operation, many distressing conditions formerly untreated were brought to the surgeon for relief, and as surgeons gradually became more deliberate in their work a higher perfection in technic resulted.

General Anæsthesia.

General anæsthesia is employed chiefly to render surgical operations painless, to diminish suffering during parturition, to produce muscular relaxation for the reduction of hernias, fractures, and dislocations, and for purpose of thorough physical examination; occasionally to give relief in painful surgical disorders such as the passage of a renal calculus or gall-stone, and in cases of intense neuralgia.

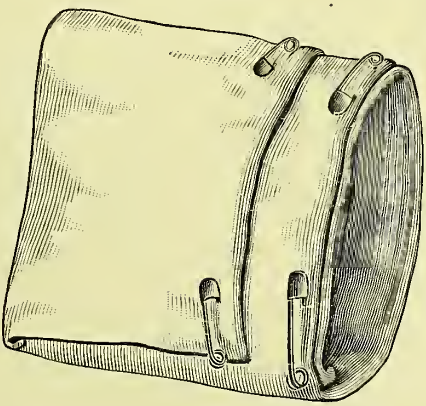
General anæsthesia is contraindicated in cases of uncompensated valvular disease of the heart, in myocarditis, in extensive disease of the lungs or kidneys, in diabetes with marked acidosis, in newborn children, in advanced age, and in conditions of severe shock.

Nitrous Oxide.—Although the anæsthetic properties of nitrous oxide gas were known long before the discovery of ether and chloroform, it was not until general anæsthesia had to a certain extent become popularized by the use of these agents that the employment of nitrous oxide became general. The inhalation of pure nitrous oxide gas rapidly produces unconsciousness and insensibility to pain. The patient after two or three deep inhalations shows a certain degree of muscular spasm and slight tremor ; the pulse becomes rapid, the eyes fixed, the face gradually becomes cyanosed, the respirations stertorous, and a condition of anæsthesia results, which persists for from one to two minutes after withdrawal of the drug. Following this the patient rapidly regains consciousness without nausea or other untoward symptoms. Nitrous oxide is useful for short operations not requiring absolute muscular relaxation, and in longer operations when it may be given in combination with oxygen. It is frequently employed to produce rapid anæsthesia preliminary to the administration of ether to save time and to avoid the disagreeable choking sensations of the ether. The apparatus required for the administration of nitrous oxide consists of a metal cylinder in which the gas is stored in a liquid state under high pressure, a rubber bag connected by a flexible tube with a hollow spherical face mask provided with a valve to allow the escape of expired air. The bag is filled with gas, the face mask tightly applied, and the patient instructed to breathe deeply. Anæsthesia is generally produced in from thirty seconds to two minutes.

Ether.—The inhalation of the vapor of ether, if skilfully administered and combined with a considerable quantity of air, gives rise at first to a sensation of giddiness and mild intoxication ; there are often a slight sense of constriction about the larynx, and salivation from irritation of the fauces. If the vapor is administered in greater concentration, the choking sensation is more pronounced and the patient struggles to be free from the cone. When more of the drug is given the face becomes flushed, the pupils dilated, the pulse rapid, and the respirations are increased in frequency ; the patient becomes talkative, the speech is thick and unintelligible, there may be muscular spasm or tremor, after which the respirations gradually become slower and deeper, the muscles relax, the conjunctival reflex is abolished, and the patient appears to be sleeping naturally. In this condition the pupil may be normal, slightly contracted or dilated, but reacts to light ; there is complete insensibility to pain, and the patient is ready for operation. In certain individuals the stage of excitement is of longer duration and more violent. In these cases, after a certain amount of the drug has been inhaled, they have vivid hallucinations and illusions—often of persecution. They scream and struggle and swear and fight, and unless controlled by assistants not infrequently jump from the table and attempt to escape from the imaginary danger. As a rule, however, they quickly regain consciousness, and are easily persuaded to lie down and inhale more of the anæsthetic. In other instances, especially in alcoholics, the stage of excitement is accompanied by severe and prolonged muscular spasm, and violent tremor, which may persist until the most profound degree of anæsthesia is reached. When the muscles of the glottis are affected, respiration is completely suspended and the patient becomes profoundly cyanosed. The condition is alarming to inexperienced anæsthetists, but is without danger, as the spasm always passes away if the cone is removed from the face and the position of the tongue such as to allow air to pass freely to the larynx.

The *administration* of ether is accomplished best by means of an inhaler made of a towel stiffened with several layers of newspaper, as seen in Fig. 88. The advantages of this inhaler are that it is absolutely clean, it may be made to fit any face, it insures an abundance of air during the administration of the ether, it never gets out of order, and may be made in any house. The Allis inhaler is made of a soft-rubber hood open at both ends with a folded flannel obturator at one end, upon which the ether is poured, and possesses most of these advantages. The Clover

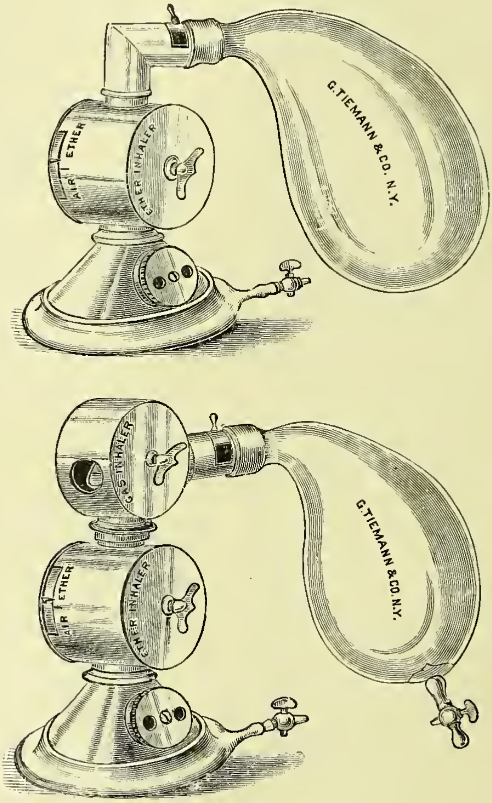
FIG. 88.



Ether cone: newspaper and towel.

apparatus, or, better, the Bennett modification of this, is perhaps the most popular apparatus now in use (Fig. 89). This apparatus consists of a face cone, the periphery of which is covered by a pneumatic tube to insure accurate adjustment, an ether cylinder, and a closed rubber bag. The gauze which fills the ether cylinder is saturated with the drug, the cone placed over the mouth and nostrils of the patient, and a generous amount of air supplied by opening the air-valve in the cylinder. By means of this valve ether vapor in any degree of concentration can be given, from pure air to pure ether. When the air-valve is closed the patient breathes into the rubber bag and the supply of fresh oxygen is practically cut off. This is known as the *closed method* of ether administration. It has the advantage of producing a maximum amount of anæsthesia with a minimum amount of ether. In

Fig. 89.



Bennett inhaler for gas and ether.

skilled hands the results are ideal. For those less accustomed to the administration of anæsthetics, the paper and towel cone is to be preferred.

If one wishes to precede the administration of ether by nitrous oxide gas, an extra cylinder and bag for the gas are supplied with the Bennett inhaler, as seen in Fig. 66.

In children, ether is best given by the *drop method*, an Esmarch chloroform inhaler being used. This method can often be employed in adults after they have once become thoroughly narcotized by more concentrated administration. It is undoubtedly the safest of all methods, but is unsatisfactory in alcoholics and others who require a larger amount of the drug.

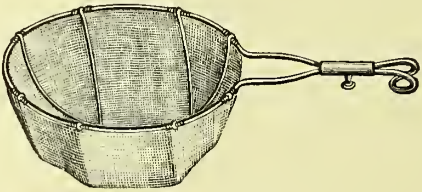
Whatever method is employed, the plan of procedure should be as follows:

The patient should be prepared by fasting to insure emptiness of the stomach, by the removal of false teeth or other foreign bodies from the mouth, and by exchanging the ordinary clothing for some loose garment, as a night-gown or bath-robe. In nervous individuals and children it is desirable to place the inhaler over the face before any ether has been applied, and to allow the subject to take through it one or two deep inspirations to demonstrate that suffocation is not a part of the process. After this a small amount of ether is poured into the inhaler, which at first is held at some little distance from the face until the patient grows accustomed to its smell. The inhaler is then gradually lowered until it is snugly applied over the mouth and nostrils. Ether is then added more freely until the inhaled air contains about 90 per cent. of ether vapor. This should be continued until a condition of profound surgical anæsthesia is reached, after which just sufficient of the drug should be given to keep the patient quiet. As a rule, this requires very little, if the anæsthetist is watchful and does not allow the patient to recover to the stage of moving about or reacting to pain. The best guide is the conjunctival reflex. When this is present, give just sufficient to abolish it without producing dilatation of the pupils or puffing respiration.

Chloroform.—The effect produced by the inhalation of chloroform vapor is much the same as that produced by ether. There is considerably less irritation of the mucous membrane of the nose and throat; there is practically no choking, coughing, or salivation, the odor is agreeable to most patients, and the administration is not, as a rule, resisted. The stage of excitement is often absent, the patient continuing to breathe quietly until completely anæsthetized. Exceptionally the stage of excitement is marked and the patient may struggle violently. Muscular spasm and tremor may also be present. Cyanosis from spasmodic closure of the glottis is rare. Suspended respiration unaccompanied by muscular spasm, however, is comparatively frequent during the administration of chloroform, and demands prompt action, as it is due to the depressing effect of the drug on the respiratory centres, rather than to mechanical obstruction in the larynx, as in the case of ether. Cardiac weakness, evidenced by a sudden decline in the force of the pulse, with lowered arterial tension and irregularity, will occasionally occur during the administration of chloroform, due also to the toxic effect of the drug. Both of these conditions may arise without warning in perfectly healthy individuals and often before the patient has had sufficient of the drug to produce surgical anæsthesia.

Chloroform may be administered by holding a folded handkerchief or several layers of gauze in the form of a cone over the face and allowing the chloroform to drop upon it. The apex of the cone should be two or three inches above the mouth to allow a generous admixture of air. The most convenient method, however, is by means of the Esmarch mask (Fig. 90), which consists of an oval wire frame covered by flannel or muslin. In the administration of chloroform an effort should be made to give about 10 per cent. of the vapor of chloroform and 90 per cent. of air. In some cases, however, the vapor must be given in greater concentration. It should always be *dropped* from the bottle, and never *poured* on the inhaler. The hypodermic injection of $\frac{1}{4}$ grain of morphine one hour before the administration of chloroform will reduce to a very considerable extent the amount of chloroform necessary to produce anæsthesia. As direct contact of chloroform with the skin produces a dermatitis, the lips and nose should be anointed with vaselin before beginning its administration.

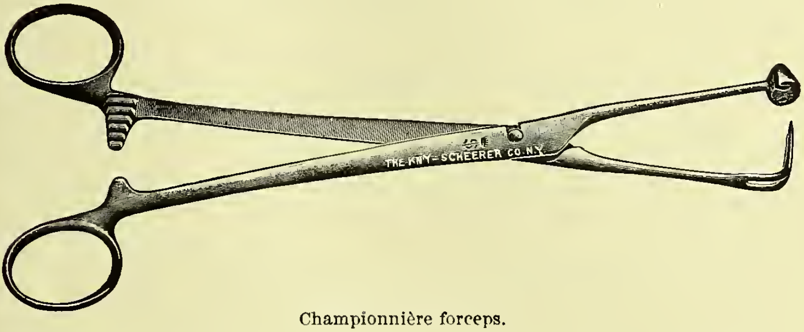
Fig. 90.



Esmarch inhaler.

Complications Arising during the Administration of General Anæsthetics, and Their Treatment.—Coughing and choking should be relieved by temporarily withdrawing the inhaler and allowing one or more full inspirations of pure air, then giving the anæsthetic more slowly. If the stomach contains food, and vomiting occurs, the patient should be turned over, the head lowered, and the vomited matter carefully swabbed from the throat and mouth. If vomited solid matter is inhaled into the larynx or trachea, tracheotomy should be performed. When the stomach is empty the anæsthetic should be resumed. If there is doubt regarding the emptiness of the stomach, it should be washed out before the anæsthetic is given. Cessation of respiration during the administration of ether, with spasm of the glottis and general muscular rigidity, needs only the temporary removal of the inhaler; as soon as the spasm is relaxed the anæsthetic should be pushed, as the symptom is due to incomplete anæsthesia. Cessation of respiration without muscular spasm is often due to closure of the glottis by dropping backward of the tongue, and is relieved by drawing the angles of the jaw well forward, or by drawing the point of the tongue out of the mouth in an upward direction by means of a tongue-forceps (Fig. 91) or silk thread passed through the organ in the median line. Cessation of respiration during the administration of chloroform may be due to these same causes, but is often the result of the toxic action of the drug on the central nervous system. These cases require prompt treatment by artificial respiration, lowering the head, and placing the body in an exaggerated Trendelenburg position. During the artificial respiration the chest should be exposed and slapped with a wet towel; ether should be poured on the epigastric region; rhythmic traction should be made on the tongue by drawing it outward during inspiration and allowing it to recede during expiration. Oxygen should be administered and a faradic current applied by one pole to the back of the neck, the other to the region of the ensiform appendix or along the phrenic nerves. Not infrequently the sudden substitution of ether for chloroform will stimulate respiration if the reflexes are not abolished. If the heart action becomes weakened, the hypodermic use of strychnine, atropine, and whiskey is indicated, and an enema of hot coffee should be given. Intravenous infusion of hot

FIG. 91.



Championnière forceps.

normal salt solution may be useful after the acute crisis is passed to improve the vascular tone.

Post-operative Complications of General Anæsthesia.—*Vomiting* during and after recovery is present in a certain number of cases, and is due to administering the anæsthetic while the stomach contains food, to the use of an unnecessarily large amount of the agent, and also to the toxic effect of the drug. It more frequently follows the use of ether than chloroform, but is rather more persistent after the latter. It should be treated by absolute rest of the organ, as anything introduced into the stomach tends to increase its irritability and to postpone the time when food can be taken and retained. If post-operative vomiting persists after a reasonable time, gastric lavage will generally relieve it; in fact, after a prolonged anæsthesia it is often of decided advantage to wash out the stomach before the patient leaves the operating table.

Acute dilatation of the stomach occasionally follows general anæsthesia, especially after abdominal operations. The condition which is described in Chapter XIX. is a serious one and demands prompt treatment by lavage frequently repeated, a change in the position of the patient, and the administration of strychnine.

Sudden *heart-weakness* and even death occasionally may follow anæsthesia, due to some unusual strain upon a chronically diseased heart, as assuming an upright position or struggling with an attendant while recovering from the effects of the drug. Patients with myocarditis should be carefully watched until fully conscious.

Pulmonary irritation, bronchitis, pneumonia, and the lighting-up of an old tuberculous focus occasionally follow the administration of ether or gas, and are presumably due in most cases to the inhalation of septic mucus from the mouth or nostrils, or of particles of food and vomited matter. Ether pneumonia occurs with greater frequency during the winter months, and in cases in which considerable bronchorrhœa was noticed during the administration of the drug. Chloroform narcosis appears to be singularly free from pulmonary complications. Both ether and chloroform should be regarded as renal irritants, chloroform more so than ether; yet renal congestion and nephritis follow anæsthesia from ether more frequently than that from chloroform for the reason that so much more of the drug is used. It is doubtful if either agent, when skilfully administered in moderate quantity, can produce these effects in persons with healthy kidneys, but it is extremely common by their employment to light up an old and quiescent renal trouble into an acute nephritis with symptoms of uræmia or of complete suppression of urine. *Diabetic coma* may be brought on by the use of anæsthetics in glycosuric individuals. *Late chloroform-poisoning*, an exceedingly fatal complication, is described under Acute Acidosis, page 120.

A more or less persistent paralysis of some or all of the muscles of an extremity may follow general anæsthesia, due in most cases to a neuritis from pressure. The prognosis in these cases is generally favorable, although the symptoms may persist for months.

Choice of Anæsthetic.—When general anæsthesia is to be employed, the choice of the agent to be used is an important matter. Ether is undoubtedly the safer of the two in healthy individuals. The death-rate in healthy individuals when ether is administered by a competent anæsthetist is practically *nil*, while the death-rate following the employment of chloroform under these conditions is variously estimated at from 1 in 800 to 1 in 5000. The report of the Committee on Anæsthetics of the British Medical Association, in 1901, gave 18 deaths due to chloroform in 13,393 cases, and no deaths from ether in 4595 cases. Ollier reports 40,000 etherizations without a death, and McGuire 28,000 chloroformizations without a death. It is evident to the writer that none of these statistics give us an accurate idea of the danger of general anæsthesia. Undoubtedly in the experience of certain specialists when anæsthetics are administered only in comparatively healthy individuals, and where ample preparatory treatment can be carried out, the death-rate is exceedingly low; but in a large general surgical practice, where emergencies have to be met and operations performed in people of all ages and under all conditions of disease, dissipation, and malnutrition, the death-rate is considerable. If we consider the remote deaths directly traceable to ether from pneumonia, the lighting-up of old tuberculous processes, or from nephritis, the death-rate will certainly approach that of chloroform.

Experience teaches, therefore, that ether is to be preferred in healthy adults, in all cases of shock, and in most patients with chronic heart disease. Chloroform is to be preferred in infancy and in old age, in acute and chronic disease of the lungs, arteries, or kidneys, and in operations upon the throat and air-passages. It should be remembered that the vapor of ether is inflammable.

Ethyl bromide and *ethyl chloride* have been quite extensively employed to produce anæsthesia for short operations, the advantages being that anæsthesia can be induced in a very few minutes and that recovery is rapid and unaccompanied by nausea or other unpleasant symptoms.

Methyl chloride has been employed to a certain extent, particularly in France. Like the ethyl compounds, it produces prompt anæsthesia and is said to be safe, but it has the disadvantage of not producing muscular relaxation.

Somnoform.—Rolland, of Bordeaux, sought, by combining ethyl chloride, ethyl bromide, and methyl chloride, to produce an anæsthetic which would unite the advantages of all these agents and minimize their disadvantages. It produces prompt anæsthesia without disagreeable symptoms, but, in the writer's experience, is in no way superior to nitrous oxide. Rolland has reported 23,000 anæsthesias with this mixture without accident.

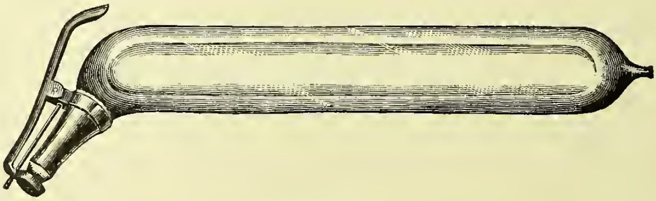
Anesthol.—Willy Meyer has recently suggested the use of this agent, which is a combination of ether, chloroform, and ethyl chloride, in such proportions as to render the boiling-point of the mixture 104° F. This, it is claimed, insures more rapid elimination, shortens the stage of recovery, and diminishes the danger. It should be given by the drop method on an Esmarch inhaler. Meyer has employed this method for ten years in the German hospital and in private practice, and prefers it to all other anæsthetics.

The *A. C. E. mixture* is composed of alcohol, chloroform, and ether, and was supposed to be safer than chloroform, and to do away with many of the unpleasant features of ether. Experience has shown, however, that these claims cannot be substantiated. While time may demonstrate the safety and advantages of these mixtures, at the present time one does not feel justified in recommending them in place of nitrous oxide, ether, or chloroform.

Local Anæsthesia.

Freezing a part by means of ice or a mixture of crushed ice and salt locally applied, was formerly employed to diminish the pain of short operations, as the opening of an abscess or incision of a felon. Later it was found that spraying the part with ether by means of an ordinary hand atomizer produced the same effect more rapidly and with less trouble. Recently, however, the use of **kelene**, or chemically pure ethyl chloride, has superseded all other freezing methods. This drug can now be obtained in small glass tubes having a minute opening closed by a metal cap or valve at one end (Fig. 92). When the cap is removed, a fine stream of the fluid can be directed to the part to be operated upon, by the heat of the hand expanding the fluid contained in the tube. This by its rapid evaporation produces a prompt freezing of the tissues, rendering incisions painless.

FIG. 92.



Kelene tube.

All of these methods are objectionable on account of the pain which is always an accompaniment of the thawing process, and which, in the writer's experience, is far worse and more lasting than the pain produced by an incision without freezing.

Cocaine.—The application of a 4 per cent. aqueous solution of cocaine hydrochlorate to a mucous surface for five or six minutes will produce complete insensibility to pain. Stronger solutions or a few crystals of the salt applied to a small area will produce the same effect more promptly. External applications to the skin have no effect. Hypodermic injections of weaker solutions will produce insensibility along the line of injection. It has been found that the best results are obtained if the solution is injected into the deeper layers of the skin rather than into the subcutaneous cellular tissue. Extensive cutaneous areas may be rendered anæsthetic by introducing large quantities of the solution under the skin or by the injection of small quantities in the immediate vicinity of the sensory nerve-trunks supplying the part. Schleich found that infiltrating the deeper layer of the skin with an 0.2 per cent. solution of sodium chloride produced temporary anæsthesia, but that the effect was much more pronounced and lasting if minute quantities of morphine, cocaine, and carbolic acid were added. By the use of these agents he developed what is now known as *Schleich's Method of Infiltration Anæsthesia*, by which many of the larger and more important operations are performed, including amputations, laparotomies, herniotomies, thyroidectomies, and the removal of tumors. The following is the formula for the No. 1 solution:

Cocaine hydrochlorate,	0.20;
Morphine hydrochlorate,	0.025;
Sodium chloride,	0.20;
Water,	to make 100.

Sterilize, and then add 2 drops of a 5 per cent. solution of carbolic acid.

Two other solutions are employed when large areas are to be infiltrated, one solution containing one-half the amount of cocaine and the other only one-twentieth. The area to be operated upon should be surrounded by a circle of infiltrated skin, an effort being made to inject the solution into the papillary layer. The needle should be introduced its entire length, and the fluid slowly injected as it is withdrawn. The second puncture should be made by penetrating the skin at the extreme end of the anæsthetic zone. The method can be made entirely painless by rendering the point of primary puncture insensible by ethyl chloride. The deeper parts can be infiltrated before or after incision through the skin.

This method was devised by Schleich on account of the frequent occurrence of alarming toxic symptoms when large quantities of the stronger solutions were employed. These symptoms are pallor, tremor, mild delirium, talkativeness, excessive perspiration, general weakness, and a rapid, feeble pulse. In the severe cases there are great prostration, syncope, and occasionally death from heart-failure or respiratory paralysis. The indications for treatment are to promote rapid elimination and to stimulate freely. Solutions of cocaine cannot be boiled for more than two minutes without decomposition. All solutions of cocaine for hypodermic use should be freshly made, and subjected to a heat of 212° F. in a water-bath for one or two minutes.

Eucaine is much safer than cocaine and possesses nearly as well-marked anæsthetic properties. It is used in from 2 to 4 per cent. solutions, both on the mucous membranes and by hypodermic injection. Solutions of eucaine can be sterilized by boiling. The hypodermic use of this agent is occasionally accompanied by pain, and it is said to cause sloughing in badly nourished tissues.

Other local anæsthetic agents are constantly being introduced, among which may be mentioned tropacocaine, stovaine, holocaine, novacaine, and nirvanine. All of these have their uses and advantages, but cocaine still remains the most reliable for ordinary use.

Spinal Anæsthesia.

The injection of a small amount of a 2 per cent. solution of cocaine into the subarachnoid space of the lumbar spine results generally in a more or less complete analgesia of the parts below this point, and often for a considerable distance above. This method of producing anæsthesia was first suggested to the profession by Corning in 1885, but was not extensively used for surgical purposes until the publication of Bier's report in 1899. Since that time it has been frequently employed for operations of all kinds on the lower extremities, the male and female genital organs, the rectum, in hernias, and in some laparotomies. After a successful injection insensibility to pain is generally complete in from six to ten minutes. The upper limit of the analgesia is usually at some point between the umbilicus and pubes, but it may be as high as the nipples, or even the axillæ.

Method of Injection.—The cocaine solution should be prepared by dissolving the cocaine crystals in distilled water and then placing a test-tube containing the solution in boiling water for two minutes.

The lumbar region of the patient should be prepared as for any aseptic operation, and the patient placed in Sims' position, with the spine well arched forward, or, as preferred by many, in the sitting posture, with the elbows resting on the thighs. A slender hypodermic needle three and one-half inches in length should be introduced at a point three-quarters of an inch to the outer side of the tip of the fourth lumbar spine, and carried obliquely inward and upward, passing between the laminæ of the fourth and fifth lumbar vertebræ until the subarachnoid space is reached. This is evidenced by the appearance of a few drops of clear cerebrospinal fluid at the external orifice of the needle. After the escape of five or six drops the syringe, filled with the cocaine solution, is screwed to the needle, and from 8 to 15 minims of a 2 per cent. solution injected. The needle is then withdrawn and the minute cutaneous wound sealed with sterile zinc oxide plaster or collodion. In highly nervous individuals it is often desirable, in order to distract their attention, to go through the form of administering a general anæsthetic by using a cone moistened with alcohol or ether. It should be remembered that an appreciation of contact remains in these cases—the patient may feel the pressure of the knife, but he experiences no painful sensation.

Spinal cocainization is frequently followed by severe headache, vomiting, and fever, which persist often for from six to thirty-six hours. Sometimes these symptoms are promptly relieved by the hypodermic injection of $\frac{1}{50}$ grain of glonoin, $\frac{1}{150}$ grain of hyoscine hydrobromate, or, as suggested by Kuster, by lumbar puncture and the withdrawal of about 10 c.c. of fluid. It is unsafe to make the injection above the second lumbar vertebra on account of the danger of wounding the cord or producing hemorrhage.

With a view to avoiding the unpleasant after-effects of cocaine spinal anæsthesia, many surgeons have experimented with some of the newer local anæsthetics. Oehler has recently reported a series of 1000 cases, and large numbers of observations have been made by Kuster, Holzbach, and others. The concensus of opinion seems to be that tropococaine and novocaine have advantages over cocaine in that they are less toxic, and, therefore, less likely to be followed by headache and severe vomiting. Eucaine and stovaine seem to be less reliable when employed in this manner. Bier and others have advocated the addition of a small amount of adrenalin to the solution, which delays absorption, prolongs the anæsthesia, and diminishes the unpleasant sequelæ. In the technic of administration it has been suggested that it is well to withdraw an amount of cerebrospinal fluid equal to the amount of solution ejected. Huntington, of San Francisco, who has had an extended experience with tropococaine, dissolves 1 grain of the drug in the fluid removed from the spine and immediately reinjects it.

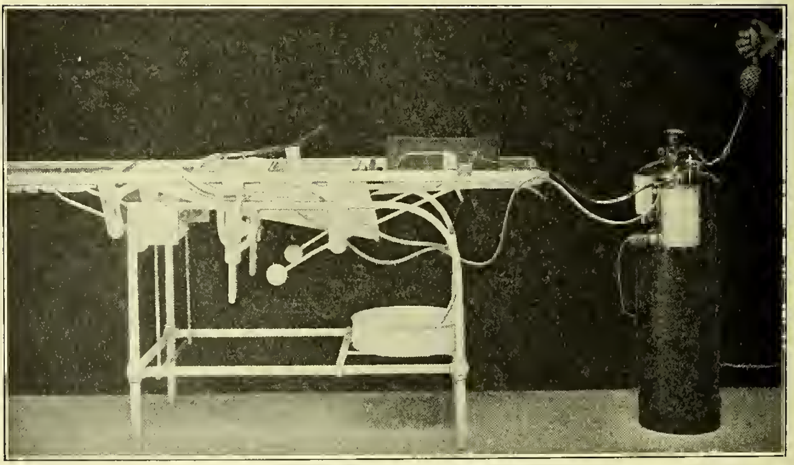
Temporary and complete paralyses have been reported following spinal anæsthesia, and a sufficient number of deaths have followed its employment to demonstrate that the method in perfectly healthy individuals is more dangerous than the employment of general anæsthesia.

Spinal anæsthesia is to be recommended only in cases in which positive contraindications exist to the use of the other anæsthetics, and occasionally in emergencies in which a skilled assistant is not available or when other anæsthetics cannot be obtained.

Rectal or Colonic Anæsthesia.—The administration of ether by the rectum was recommended and employed to some extent twenty years ago. While this method of anæsthesia possesses obvious advantages in operations about the head, face, and respiratory passages, it gradually fell into disfavor on account of the uncertainty of effect and the fact that it occasionally gave rise to a severe and sometimes fatal colitis.

Experiments have shown that the former objection was due to the introduction of the vapor under too much pressure, which resulted in driving the blood from the distended bowel and thus prevented absorption; and that the latter was due to the condensation of the ether vapor in the bowel.

Fig. 93.



Sutton's apparatus for colonic anæsthesia.

Recently the method has been revived, and by care in administration, regulating the intra-intestinal pressure, making adequate provision for the ready escape of any superfluous gas, and employing oxygen in combination with the ether vapor, all of the former objectionable features have been eliminated. Dr. W. S. Sutton, of the House Staff of the Roosevelt Hospital, has devised an apparatus (Fig. 93) which fulfils all indications.

The apparatus may be described as consisting of two portions: First, the generator, in which is produced the mixture of ether vapor with air or oxygen; and second, the tube system, serving to convey this mixture into and out of the intestine.

The essential features of the generator are a small generating chamber surrounded by a water-jacket, and a large storage chamber at the side, which automatically maintains a given level in the ether in the generating chamber. Saturation of the air or oxygen used as a vehicle for this vapor is accomplished by causing the gas to take a spiral course beneath a metal plate immersed in the ether. The water-jacket is heated by a low candle-power incandescent bulb, and the temperature recorded by a thermometer projecting through the top of the chamber. The pressure of the vapor in the generator, and hence in the bowel, is shown by a mercury manometer inserted into the cap of the generating chamber.

The tube system consists of a small calibre-tube conveying gas to the bowel, a larger tube serving as an exhaust, a rectal tube and a branch tube of glass or metal connecting the two former with the latter. The rectal tube has multiple fenestræ, and near the end, connecting with the branch tube, a bulb which assists in preventing leakage in cases having lax sphincters. The branch tube is so constructed as to act as a trap to catch fecal matter passing toward the generator, or the liquid ether condensed in the afferent tube and passing toward the bowel. The open end of the exhaust tube is immersed in a bottle of water which plays the part of "tell tale" for the gas exhaust; and near this open end the tube is clamped by a combination clip so associated with the afferent tube that the latter is closed by any effort to open the exhaust. An accessory tube is connected with the ether generator, and is used to administer a small additional amount of ether by mouth in difficult cases.

It is essential before attempting the administration of ether in this manner that the bowel be emptied by one or two preliminary enemata. The mercury in the manometer should not be allowed to rise above 10 mm.

CHAPTER IX.

INJURIES AND DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUES.

Burns and Scalds.

BURNS and scalds are injuries due to the effects of heat. Burns are caused by contact with a flame or some hot solid substance, by exposure to the rays of the sun, or the *x*-rays, by contact with a strong electric current, or simply by heat radiated from flame or some hot object. Scalds are produced by contact with steam or some boiling or heated liquid. The nature of the two injuries is identical, although their lesions may differ somewhat in appearance. The effect of the irritation is to produce a reactionary congestion, superficial dermatitis, or more or less extensive necrosis of tissue. Dupuytren's classification of burns into six degrees has been generally adopted: first degree, characterized by simple hyperæmia of the skin; second, dermatitis with vesicles or bullæ; third, necrosis of the superficial layer of the skin; fourth, complete necrosis of the skin; fifth, necrosis of skin, subcutaneous tissue, and muscle; sixth, complete "carbonization" of an extremity.

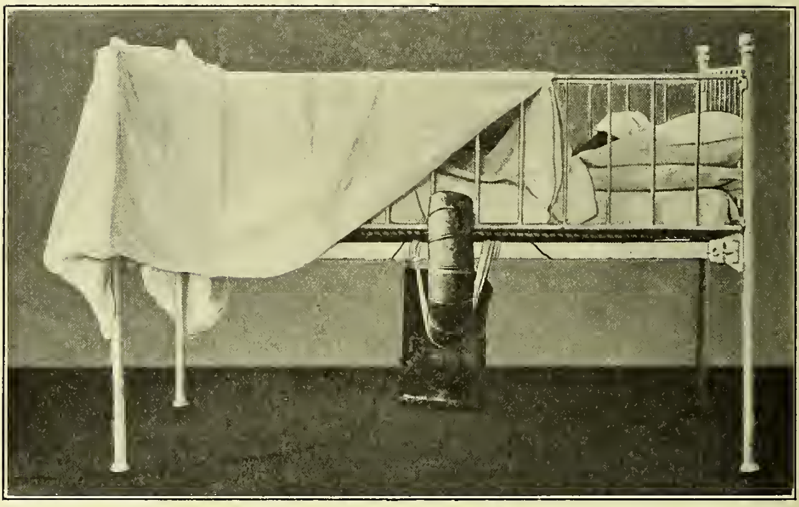
The **symptoms** of burns and scalds depend upon the location and extent of the injury and the character of the burning agent. They may be divided into local and constitutional.

The *local* symptoms of a burn are a sense of heat, smarting, and general discomfort, more or less pain, tenderness, and inability to use the part. In addition there are redness and swelling of the skin, blisters or sloughing. In the severer forms the skin may be blackened and leathery. In scalds the skin is whitened, thrown into rugæ, and often the epidermis is detached.

The *constitutional* symptoms of burns are often wholly out of proportion to the apparent injury, and are relatively greater in children and in cases in which the trunk is largely involved. Shock is present in nearly all burns, and is dependent more upon the location and extent of the burned area than the depth of the injury. It is generally fatal if an area equal to one-third of the surface of the body in involved, and in cases in which much less of the surface is injured in children, especially if the burn occurs on the chest or abdomen. Elevation of temperature and other symptoms of grave toxæmia are present in severe burns accompanied by extensive necrosis. This in the early stage is probably due to absorption of toxic substances from the burned tissues; later, to sepsis. Headache, restlessness, delirium, and coma may follow a burn, due to meningeal congestion and exudate, and in certain rare cases a duodenal ulcer will develop, evidenced by local pain, hemorrhage from the stomach or bowels, and in case of perforation by the sudden appearance of severe epigastric pain accompanied by evidences of local peritonitis and progressively increasing shock. A more or less acute nephritis is frequently associated with an extensive burn, and may cause death from suppression of urine or more slowly developing uræmic symptoms. When the patient has been exposed to flame, steam, or hot vapors, œdema of the glottis may occur, with severe bronchitis and pneumonia. Retention of urine occasionally results from œdema of the prepuce or swelling of the glans.

The **treatment** of burns of limited extent and of moderate severity consists in rest and the application of a dressing of a saturated solution of sodium bicarbonate, carbolic acid (1 : 100), normal salt solution, or the use of some emollient ointment, as zinc oxide or boric acid. In the severer forms, especially when the papillary layer of the skin is exposed, the burned surface should be immediately protected from the air and dressed as infrequently as possible. The pain should be controlled by small doses of codeine or morphine, although it must be remembered that in the severest cases, accompanied by grave toxæmia, morphine tends to retard elimination, and should be used sparingly. Painting the granulating surface of a painful burn with a 2 per cent. solution of silver nitrate will often give marked relief. In severe burns accompanied by necrosis of tissue, if possible the parts should be disinfected and dressed antiseptically. The plan of treating extensive burns without any dressing has of late been extensively employed. The patient is placed in a bed so arranged that the body is covered by a hood made of a blanket or piece of canvas, the head being outside (Fig. 94). The space beneath the hood is heated to about 100° F. by means of a hot-air generator or electric heater; or the patient simply lies in an ordinary bed without coverings, in a room in which the temperature is raised to 100° F. or above. As a result of this treatment the burned area is soon covered by a thick dry crust which excludes the air, gives great comfort, and allows the healing process when aseptic to advance as under any other protective dressing. In extensive burns, where the crust formation is slow, it may be favored by the use of an electric fan, which promotes rapid drying of the moist surfaces. In favorable cases cicatrization takes place beneath the crusts. Where much infection is present, or when the resistance of the individual is reduced, suppuration occurs beneath the scabs, and may give rise to marked systemic reaction. Occasionally this may be reduced by removing a portion of the scab to allow drainage, but generally it is better to remove the crust by a warm bath and allow another to form, or treat the ulcer by a wet asceptic dressing or some antiseptic powder.

Fig. 94.



Dry warm-air treatment of burns. Electric heater under crib with warm-air pipe on each side.

Shock should be treated by stimulants and food, meningeal irritation by sedatives and ice to the head, visceral congestion by a cold-water coil. An effort should always be made to promote elimination of the toxins by cathartics and diuretics; and if sepsis follows, supporting measures should be faithfully employed.

The healing of large granulating surfaces may be hastened by strapping or skin-grafting.

Contusions.

These are cutaneous and subcutaneous injuries caused by blows or crushes, and are associated with rupture of one or more small vessels in the skin or cellular tissue. The hemorrhage thus produced may be slight, giving rise to a dark-bluish discoloration of the skin; or it may be greater in extent, and form a large collection or hæmatoma. Contusions often are associated with wounds of the skin and other injuries of the soft parts.

The **treatment** of contusions, when any is necessary, should consist in rest for the part and the application of heat or cold by means of fomentations or wet dressings of aluminum acetate. If uninfected, and not increasing in size, hæmatomata should not be opened; the fluid, however, may be withdrawn by aspiration. If infection occurs, a free incision should be made, the cavity emptied of clots, thoroughly disinfected, and closed with sutures and drainage, or packed and allowed to heal by granulation.

Dermatitis.

The various forms of simple dermatitis are described in text-books on Dermatology.

Erysipelas is described in Chapter III.

X-ray Dermatitis.—Exposure to the Röntgen rays produces a variety of skin lesions. A single long exposure may give rise to an area of hyperæmia which is tender to the touch, and often the seat of some spontaneous pain, the so-called *x*-ray burn. More prolonged exposure to the rays or repeated exposures may give rise to chronic hyperæmia, dryness of the skin from atrophy of the sweat glands, deformed and brittle nails, keratoses, papillomata, and superficial and deep ulcerations. These lesions are all exceedingly chronic, and any ulcerative process is apt to be associated with severe pain.

Porter and White have recently reported the histories of eleven cases where *x*-ray ulcerations have undergone epitheliomatous change. All of these occurred in *x*-ray operators, and in many cases the disease began before the general use of protective agents. In one case illustrated in their report, ten different epitheliomatous tumors developed in a period of five years, requiring twenty-five operations under ether.

Treatment.—The treatment of the milder cases of *x*-ray dermatitis consists in soothing applications and the avoidance of all sources of irritation. Vaseline, cold cream, orthoform, and a wet dressing of aluminum acetate will be found useful. For the ulcerative lesions which resist palliative treatment, excision with skin-grafting constitutes the best treatment. For ulcerations which show beginning malignant change, wide excisions may be tried if the lesions are small and without evidence of lymph-node metastasis; in more advanced disease amputation is to be recommended.

Furuncle, or Boil.

Furuncle is a localized inflammation of the skin around a hair-follicle or the duct of a sebaceous gland, due to an infection, generally by Staphylococcus pyogenes aureus or albus. The tissues in the immediate neighborhood of the follicle or duct become necrosed and surrounded by an area of congestion and inflammatory exudate. If undisturbed, the necrotic mass gradually softens and forms a small cavity filled with pus, which eventually ruptures through the epidermis, discharges, and heals. Boils are apt to appear in crops and often in apparently healthy individuals, due to infection being carried from one part to another by fingers or articles of clothing.

The **symptoms** of a boil are first a localized point of tenderness, which is soon followed by a small reddened conical area of induration, on the apex of which a small vesicle is often seen. There is usually considerable pain of a throbbing character, with marked tenderness and muscular rigidity in the region. Furuncles may occur anywhere, but are seen more frequently on the neck, face, buttocks, arms, and in the axillæ.

The **treatment** should be to promote early softening of the necrosed mass and evacuation of the pus. This is accomplished best by a wet dressing of mercuric chloride (1 : 5000) or a flaxseed poultice, with incision as soon as softening is detected. While most modern surgical authorities condemn the use of the poultices on the ground that they favor the spread of infection by allowing the pus from a discharging furuncle to infect surrounding healthy follicles, there is no objection to their employment before the focus is opened, at which time they often relieve pain, favor early softening, and contribute to the comfort of the patient.

The use of Bier's hyperæmic cups after a comparatively small incision will hasten resolution in many cases and avoid conspicuous cicatrices. Early incision through the necrosed area, followed by a wet bichloride dressing, will often save time by aborting the process. Removal of the offending hair when present and applying pure carbolic acid to its follicle by means of a pointed match or toothpick is recommended in the early stages. To prevent a succession of boils, the surrounding parts should be washed frequently with soap and water, afterward bathed with a solution of bichloride (1 : 1000), and protected by a dressing of sterile gauze. Care should be taken to disinfect the fingers after dressing or handling the infected region. Furuncles often may be aborted by the application of an ointment or plaster of salicylic acid. Klotz's formula is the following :

℞.	Empl. plumbi,	60. ;
	Empl. saponis,	25. ;
	Petrolati,	8. ;
	Cerat. jap.,	2. ;
	Ac. salicylici,	5.—M.

Carbuncle.

Carbuncle is a circumscribed inflammation of the skin and subcutaneous tissues resulting in a more or less extensive area of necrosis. As in the case of a furuncle, infection usually takes place through a hair-follicle or gland-duct, and, in the majority of instances, is caused by one of the staphylococcus group. The process is generally an indolent one, and little pain is experienced until the induration has extended well into the tissues, forming a circular flattened mass, which is slightly reddened or bluish in color and often studded with numerous small vesicles or areas of superficial necrosis. Carbuncles vary in size from that of a pea to an area eight or ten inches in diameter. While carbuncles may occur in any part of the body, they are most frequently encountered on the back or neck. This is due to the peculiar arrangement in these parts of the subcutaneous areolar tissue and fat. In this region the skin is thick and the cutis vera dense and fibrous. Oblique columns of fatty tissue (*columnæ adiposæ*) connect the subcutaneous fatty tissue with the small hair-follicles. Infection of one of these hair-follicles extends downward to the fatty layer along one of these columnæ adiposæ, and spreads beneath the skin. It ascends along other fatty columns to the surface, giving rise to the numerous pointing foci. The occurrence of carbuncle is favored by diabetes, chronic nephritis, infectious fevers, malnutrition, or diminished vital resistance from any cause.

The **symptoms** are slight localized pain, the presence of an indolent, moderately painful induration of the skin and general malaise. As the disease advances vesicles appear on the overlying skin, which rupture spontaneously and exude a thin seropurulent fluid. Through the small openings thus formed a grayish-white slough is seen which shows little tendency to liquefy and discharge. Later, in neglected cases, the entire epidermis sloughs, leaving a ragged, foul-smelling ulcer filled with necrotic material which extends into the neighboring tissue far beyond the surrounding circle of healthy skin. Accompanying these local symptoms there is a slowly developing general sepsis, evidenced by fever, generally of moderate degree, and a rapid pulse, later by great physical prostration and often low delirium.

The **treatment** of carbuncle should follow the same principles as in other septic conditions, that is, to remove the focus and combat the general sepsis. This is accomplished best by complete excision of the carbuncle rather than by crucial incisions, which leave large infected masses of tissue to slough off, during which process there is continued absorption which retards repair and convalescence. As in the treatment of furuncles, the use of Bier's hyperæmic cups is to be recommended. In addition to the local treatment the patient should be given an abundance of easily digested nourishing food, stimulants, and tonics. Excretions of toxins should be favored by free diuresis, diaphoresis, and moderate catharsis. The site of the carbuncle should be skin-grafted, if large, as soon as the conditions are favorable.

Cellulitis.

Cellulitis is a septic inflammation of the cellular tissue due to infection from without, generally introduced through a wound of the skin or an abraded surface. Cellulitis may occur wherever areolar tissue is found, but in the majority of instances it attacks the subcutaneous and intermuscular cellular tissues of the extremities. Two clinical varieties are observed, the localized and the spreading. In the former the local symptoms are more prominent and the process generally ends in the formation of an abscess ; in the latter the local symptoms may or may not be well marked, but are characterized by a tendency to spread rapidly along the lymph-chanels toward the trunk, and are generally associated with well-marked evidences of systemic poisoning. The localized forms of cellulitis are generally due to infection by one of the staphylococcus group, while in the spreading variety streptococci are generally found. In a series of observations recently undertaken at the Roosevelt Hospital by Dr. Carlton P. Flint it was found that 46 per cent. of the cases of cellulitis which were treated at the out-patient department of that institution were due to staphylococcus infection, 14 per cent. to the streptococcus, in 18 per cent. the infection was mixed, and in 22 per cent. either no growth was obtained or the organism was not positively identified.

One of the commonest forms of cellulitis which the surgeon is called upon to treat is that arising from infection of the fingers or hands. In the majority of instances it results from a cut or abrasion ; although not infrequently a hang-nail or the minute prick of a needle may be the point of origin. If the virulence of the organism is low and the resistance of the individual high, only a minute subepithelial focus of suppuration may result. As the conditions become more unfavorable, a subcutaneous abscess may develop, a spreading phlegmon, a tenosynovitis, septic arthritis, or an osteomyelitis may occur. In the most virulent cases the extension of the inflammation to the arm and axilla is rapid and is accompanied by evidences of grave toxæmia.

The **symptoms** of cellulitis vary considerably in intensity. There is usually a history of a wound followed by a throbbing pain in the neighboring parts, with swelling and redness of the skin and tenderness to the touch. The local symptoms may be confined to the region of the original infection or spread rapidly toward the trunk. In the former instance there will develop swelling and induration of the skin and cellular tissue with moderate fever, followed by softening and fluctuation ; in the latter the extension of the process will be indicated by the formation of tender red lines extending upward along the course of the lymphatic channels or superficial veins, accompanied by chills, fever, prostration, a marked leucocytosis, and other evidences of septic intoxication. The lymph-nodes along the course of the infection will become enlarged and tender. Suppuration may occur in both varieties of cellulitis. In the localized form a single abscess usually forms, in the spreading variety areas of suppuration develop often between the muscular planes, causing extensive destruction of the tissues and grave sepsis.

Of the various forms of cellulitis which occur in the finger or hand, several clinical types are to be recognized. First, the *paronychia*, a puffy redness which surrounds the base of the nail, due generally to an infected hang-nail, needle prick, or manicure trauma. The swelling is rapid, accompanied by moderate throbbing pain and tenderness, and quickly leads to a subepithelial collection of pus. Unless promptly relieved by free incision, infection of the matrix of the nail follows, which is indicated by continued suppuration beneath and around the nail, loosening of the nail, and the formation of an ugly bleeding granuloma at the cutaneous margin. This type rarely extends to the hand or arm, almost never involves the tendon sheaths, and is not, as a rule, accompanied by grave toxæmia.

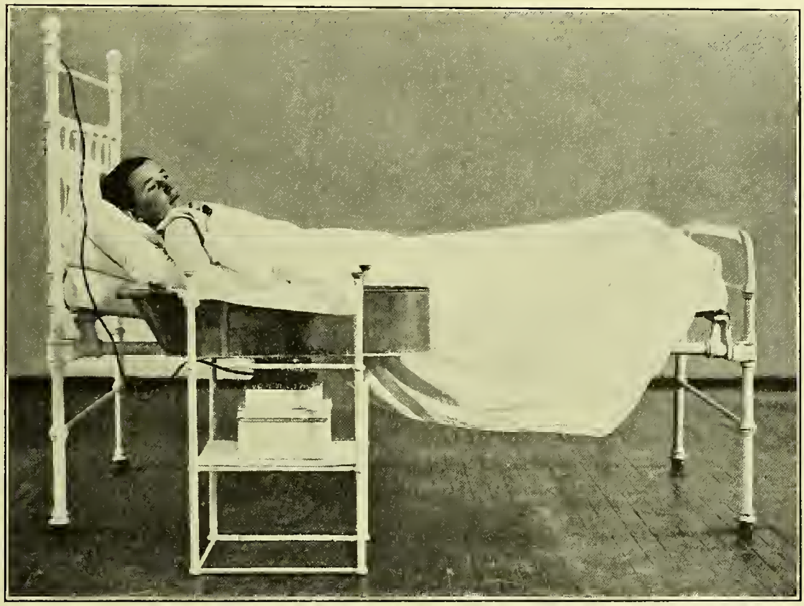
Second, the *infected needle prick*, frequently acquired by surgeons during operations on cases of virulent infection or while performing autopsies. This injury is so slight that it is often overlooked. If the virulence of the infection is low, only a small area of redness with moderate pain and tenderness develops, which results in a small subcutaneous abscess, which is promptly relieved by incision. If, however, the virulence of the infection is high and the resistance of the individual below normal, the infection may be of the fulminating type. In these cases often the first symptom is a chill, followed by high fever, headache, and marked prostration. The local symptoms at this time may be so slight as to be entirely overlooked, and the condition is often diagnosed as an acute grip or some other general disease. At a later period the infected finger will become painful, hot, and tender. Redness appears about the point of entrance of the infection and extends up the arm in longitudinal lines along the lymphatics and superficial veins. The epitrochlear and axillary lymph-nodes become enlarged and tender, and from these, as well as from the infected lymph channels, areas of cellulitis develop. The symptoms of general toxæmia increase, indicated by continued high fever, rapid pulse, delirium, nephritis, a dry tongue, and progressive prostration. Erysipelas may develop in the extremity, or metastatic accidents appear in the joints or other tissues or organs. Death not infrequently follows this type of infection, unless relieved at an early period by free incisions and adequate drainage.

Third, *bone felon.* In this type the infection frequently follows a trauma, which bruises the deeper tissues, although it may occur simply from lymphatic extension of a purely superficial lesion. Here we have to do with a septic osteomyelitis of one of the phalanges, generally followed by a subperiosteal abscess. The pain is severe and throbbing in character, there is œdema and tenderness of the entire finger with moderate fever, and evidences of mild toxæmia. As a rule, this type does not give rise to the rapidly spreading lymphatic infections, and rarely involves the tendon sheaths. Necrosis is frequent, and involvement of the intraphalangeal joints may occur from the direct extension of the bony lesion.

Fourth, infection of the tendon sheath, the *thecal whitlow* or *felon.* While this variety may result from extension of a neighboring focus, it generally arises from a direct wound of a flexor tendon sheath. If the second, third, or fourth finger is thus involved, the process is at first limited to the finger proper, as these synovial sheaths do not extend into the palm. If the thumb or little finger is the seat of infection, the process, as a rule, extends to the palmar bursa and wrist. There is severe pain in the digit, which is increased on any attempt at flexion, with œdema and tenderness over the involved tendon sheath. When the palmar synovial pouch is involved, there is a tender induration of the palm and a soft œdema of the dorsum of the hand. If the process extends, rupture into the wrist-joint or the deep cellular planes of the forearm takes place, with abscess formation, marked destruction of tissue, and progressive sepsis.

Treatment.—The treatment of cellulitis is both local and general. Of the local measures, the application of ice or a wet dressing of aluminium acetate or mecuric chloride gives a certain measure of relief, and not infrequently seems to abort or limit the spread of a cellulitis. Absolute rest of the part should be ensured, if necessary, by means of a splint. As soon as there is evidence of the presence of pus, free incision should be made and adequate drainage provided for by tubes or gauze packing. In the spreading variety early incisions along the inflamed areas before the formation of pus will often limit the disease and prevent infection of the deeper parts. The use of the continuous bath by immersing the entire extremity in a tepid solution of boric acid or weak bichloride is often of the greatest value, not only in limiting the spread of the process but also in affording marked relief of pain (Fig. 95). In cases of virulent spreading cellulitis of the arm after septic wounds of the hand or finger, accompanied by rapid enlargement of the axillary gland with progressive sepsis, complete removal of all the lymphatic structures of the axilla has often been followed by a sudden and satisfactory arrest of the general sepsis. The propriety of this operation is, however, open to question, as the function of the lymph-nodes is undoubtedly to protect the organism from septic infection by arresting the septic material being carried through the lymph-channels to the blood, and their complete removal would tend to leave the individual poorly equipped to meet a subsequent septic emergency.

Fig. 95.



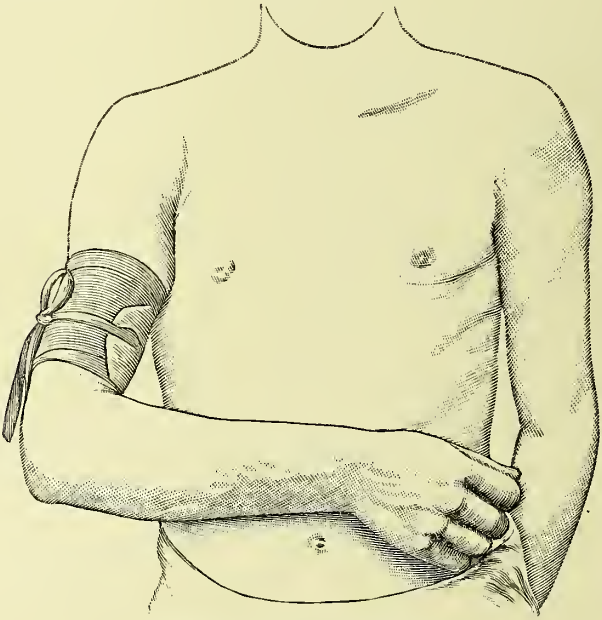
Continuous bath for cellulitis.

The general treatment of cellulitis should consist of supporting measures, stimulants when necessary, and attempts to increase the elimination of toxins by free diuresis, diaphoresis, and occasional free catharsis if the condition of the patient will permit. The patient should be urged to take a large amount of water and fluid food. Digitalis, strychnine, and nitroglycerin will be found to be useful; also an occasional dose of calomel or salts. Prolonged rectal irrigations with salt solution, intravenous infusions or hypodermoclysis, will often prove of great value.

The treatment above outlined has been the one generally employed by surgeons in the past. While it has been successful as a rule, it must be admitted that this success has been attained through slow and painful processes, and often has been followed by impairment of function, marked deformity, and unsightly scars.

Some years ago Bier, believing that in the treatment of all infectious processes, an effort should be made to imitate Nature's method, which is to supply a greater amount of blood to an injured or infected part, suggested the use of his hyperæmic methods which had been so successful in the treatment of tuberculous joint disease. In cases of cellulitis of an extremity he applied the constricting rubber band (Fig. 96) well above the inflamed area and allowed it to remain in place for from four to twenty-two hours out of the twenty-four.

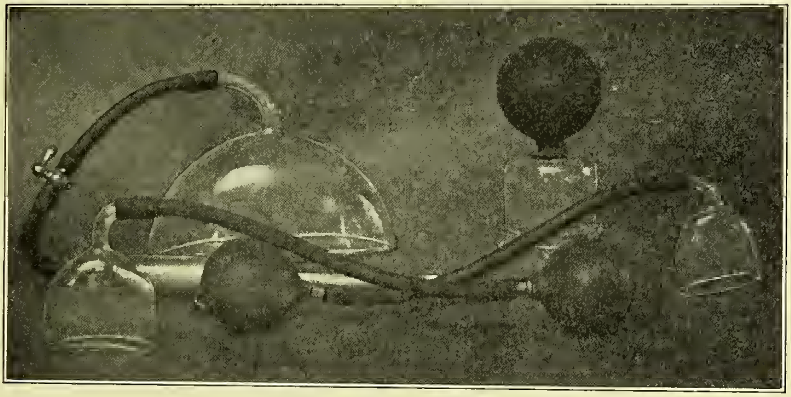
Fig. 96.



Bier's constriction bandage.

In applying the bandage care should be taken not to apply enough pressure to cause pain or to obliterate the arterial pulse. Klapp, a pupil of Bier, later produced the same effect by various forms of suction cups (Fig. 97). The method of suction hyperæmia is most useful in cellulitis of the fingers or hand or where the process is limited to a small locality, as in the breast, face, neck, or buttock. In furuncles, carbuncles, small areas of cellulitis on the fingers or toes, the suction cup is applied for five or ten minutes, then removed for three or four minutes, and reapplied for the same length of time. This is kept up for from one-half to three-quarters of an hour once or twice a day. In the more extensive or more virulent infections of an extremity the constricting band is employed, and should be left in place the greater part of the twenty-four hours, changing its location from time to time to avoid cutaneous irritation. These methods bring about an increased blood supply to the infected part, and a marked transudation of serum into the tissues, which results in increased phagocytic action, increased bactericidal effect of the blood plasma, a dilution of the toxines by the abundant transudation of serum, and increased drainage after incision.

Fig. 97.



Bier's cups for hyperæmic treatment.

In the earliest stages of an infection the method may result in an arrest of the process. In the majority of instances, however, suppuration occurs, which should be promptly relieved by incisions. The advantages of the method are that only small incisions are necessary, gauze packing and other forms of drainage can be avoided, the duration of the acute process is shortened, resolution is hastened, and the total amount of suffering is greatly reduced. The method has been extensively employed in Germany, and is at present on trial in this country. The results which are being obtained by the method at the Roosevelt Hospital and the Vanderbilt Clinic justify the belief that in the treatment of acute infections the hyperæmic method offers many advantages over the old so-called antiphlogistic methods with large incisions and prolonged drainage.

Paronychia.

Paronychia, which is an infection of the skin around the margin of the nail, and unless promptly treated quickly extends to the matrix of the nail, has already been referred to in the previous section as one of the frequent causes of cellulitis of the hand. It occurs in two forms, the septic and the syphilitic.

In the *septic* form the symptoms are at first slight pain, tenderness, redness, and swelling of a crescentic area about the nail. Later the nail loosens, pus appears beneath the overlying skin, and an infected granuloma often develops, spreading from the cutaneous margin on to the nail. In neglected cases cellulitis may rarely develop and extend rapidly to the hand and arm.

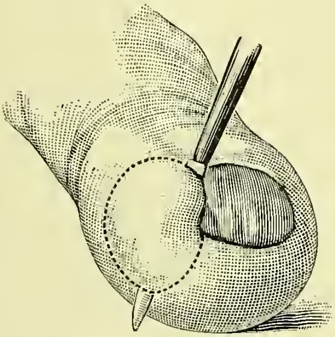
In the very earliest stage of the infection, before the inflammatory process has involved the matrix, it often can be aborted by the application of a wet gauze dressing of bichloride of mercury, 1 : 5000, covered by a rubber finger cot. At a later period when suppuration has occurred around the nail (subepithelial abscess) the process may still be arrested by the same application after removal of the pus and necrotic epidermis. When the nail loosens or a granuloma appears, the nail must be removed, the matrix exposed by a median dorsal incision, and a wet dressing applied.

In the *syphilitic* variety there is generally a gummatous thickening of the matrix with deformity of the nail and often an ulceration around its base. In other cases there is only thickening, opacity, brittleness, and deformity. In the ulcerating variety the local application of mercurial ointment is indicated, and in both varieties the exhibition of mercury and potassium iodide.

Ingrowing Toenail.

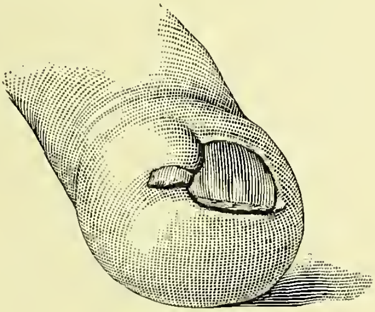
Ingrowing toenail is an imbedding of the lateral edge of the nail into the adjacent soft tissues. This generally occurs on the great toe, and is due to an abnormal bending downward of the edge of the nail, or to a crowding of the soft tissues upward around the nail from ill-fitting shoes. If infection takes place, ulceration of the skin at the point of contact with the nail occurs with more or less cellulitis of the toe. The condition is a painful one and has a strong tendency to recur. The radical treatment should consist in freely removing the exuberant tissue around the edge of the nail (Cotting's operation) (Fig. 98), or removing the imbedded portion of the nail by a vertical incision which extends well backward behind the matrix, together with that portion of the matrix which lies underneath the removed portion. This prevents regeneration of that portion of the nail. The inflammatory condition can often be relieved by rest, hot water, and lifting the edge of the nail by a small folded string of cotton placed under the free projecting surface of the nail in such a way as to separate its edges from the inflamed tissues (Fig. 99).

Fig. 98.



Cotting's operation.

Fig. 99.



Palliative treatment.

Clavus, or Corn.

Corns are conical epidermal hypertrophies occurring on the feet, at points pressed upon by ill-fitting shoes. When situated on the dorsal or plantar surface of a toe they are dry and hard; when between the toes they are softened by the perspiration. Both varieties are painful and at times disabling.

The prophylactic **treatment** consists in wearing hygienic shoes which are so constructed as to avoid undue pressure at any point. Corns may be removed by daily touching them with a mixture of salicylic acid and collodion, 60 grains to the ounce, and afterward peeling off the collodion cap with as much of the softened callus as will easily come away. Removal with the knife after soaking in hot water is quicker, and if skilfully done can be accomplished without bleeding or wounding the healthy skin. Soft corns should be treated with aristol or some other drying powder applied on cotton or gauze placed between the toes to absorb the moisture.

Rare Forms of Chronic Infection of the Skin.

Actinomycosis, blastomycosis, and syphilis exhibit a variety of cutaneous lesions. The diseases are described in Chapter IV, but for a description of the skin lesions the reader is referred to some treatise on dermatology.

Mycetoma.—Mycetoma or *Madura foot* is a chronic infection beginning in the skin of the foot, characterized by the formation of extensive granulomatous areas which slowly destroy all of the tissues of the foot and necessitate amputation of the limb. It prevails in India and other tropical countries, but is rarely seen in the United States.

Frambœsia.—Frambœsia or *yaws* is another tropical disease of the skin characterized by the formation of papular lesions chiefly in regions where skin and mucous membrane join. The lesions are more or less confluent, exhibit a purulent discharge, are often covered with crusts, and finally develop into a raw fungating bleeding ulcer, which occasionally heals spontaneously. Surgical removal by means of the cautery or curet is the treatment to be recommended.

Guinea-worm.—This disease is characterized by the formation of an oval vesicular lesion of the skin, which is caused by the presence of the *Filaria medinensis,* a long, slender worm. The disease is acquired in the tropics, and in all probability through drinking-water. The embryos are taken into the alimentary canal, migrate to the skin and develop just beneath it, where they lie coiled up, and by their presence give rise to sufficient local irritation to produce the vesicle. When the lesion is fully developed the worm occasionally can be felt through the epidermis. The lesion may be removed surgically or the worm killed by antiseptic injections.

Ainhum.—Spontaneous amputation of the finger or toe by the formation of a cicatricial ring or keloid formation, which slowly progresses and eventually cuts off the blood supply to the digit. It occurs chiefly in negroes who inhabit tropical countries, and effects by preference the fifth toe.

Ulcer.

An ulcer is a raw surface caused by a more or less extensive necrosis of the skin or mucous membrane. On mucous surfaces any loss of substance is spoken of as an ulcer. In the skin, necrosis or destruction of the epithelial layer only is called an *abrasion* or *excoriation,* the term ulcer being applied only when the destructive process has extended into the corium or below it. Ulcers not infrequently involve the subcutaneous cellular tissues, muscular and fascial layers. An ulcer may be caused by a destructive process which begins on the surface and progresses inward, as an ulcer from a burn or one resulting from a superficial trauma; or it may begin within or beneath the skin and work outward, as an abscess, or gumma, which gradually extends until the superficial layers are invaded and destroyed.

An ulcer may be caused by trauma, by the action of chemical or thermal irritants, by inflammatory processes, by pressure, by interference with the circulation of a part, by disease or interference with the trophic centres or nerve-fibres, by the sloughing of new growths or one of the infective granulomata, and by the inability to close completely large cutaneous or mucous membrane wounds occurring in surgical operations. With the exception of aseptic surgical wounds, practically all ulcers are infected with pyogenic bacteria. Most ulcers begin by an area of necrosis, which may be located superficially or below the surface. This area may be extensive, as one caused by a burn or a severe trauma; or it may be small, such as is seen often in the minute central slough of a syphilitic lesion of the skin. Around this necrotic area there will occur a zone of hyperæmia, and later a round-cell infiltration of the tissues. As a result of this inflammatory process the slough is gradually separated and may be cast off *en masse* or liquefy and be discharged as pus. If the original cause of the necrosis is a progressive one, it may extend peripherally and slough centrally, causing a gradually increasing ulcer, as seen in the serpiginous syphilides, rodent ulcer, or the ulcers of tuberculosis. When the progress of an ulcer ceases and all sloughs are cast off, granulations appear on its base, which grow rapidly and eventually fill the cavity. The granulation-tissue, at first soft and vascular, gradually becomes converted into connective tissue, the fibres of which contract and tend to draw the edges together. Cicatrization occurs from the growth inward of epithelium from the cutaneous margins.

The clinical appearances and general behavior of the various forms of ulcer differ greatly, and have led to a number of rather elaborate and unsatisfactory classifications.

Perhaps the most satisfactory classification would be that based upon their etiology. We would then have six general classes—those due to trauma, to infections, to circulatory changes, to trophic disturbances, to constitutional diseases, and to new growths.

The *traumatic ulcers* would include those due to loss of tissue from injury, from chemical or thermal agents, from electric currents, or the x-rays.

The *infective ulcers* would comprise those due to acute or chronic infections of the skin or mucous membrane, as ulcers resulting from furuncles, carbuncles, cellulitis, syphilis, tuberculosis, actinomycosis, blastomycosis, and many other acute or chronic inflammatory processes.

The *circulatory* would include those due to a diminished blood supply, as from arterial sclerosis, thrombosis or embolism, pressure, ischæmia, and those due to an impeded venous current from cardiac disease or varicose veins.

The *trophic ulcers* are those due to imperfect nutrition from loss of nerve supply to a part or from some central nervous lesion. Nerve section or neuritis, locomotor ataxia, and syringomyelia are the commonest etiologic factors in this class.

Of the *constitutional* diseases which give rise to ulcer may be mentioned scurvy, diabetes, the various forms of nephritis, typhoid fever, and other debilitating conditions.

The *ulcers due to new growth* are the epithelioma, and the secondary ulcers due to necrosis of deep-seated carcinomata or sarcomata.

In all of these classes certain clinical types of ulcer appear, some of which it is well to recognize.

The Healing Ulcer.—When the process of repair is well under way, practically all ulcers look alike. The loss of substance is replaced by a bright-red mass of granulations, which are covered with a thin layer of healthy pus; the edges of the ulcer are soft and thin, and gradually fade into a bluish film which extends over the marginal granulations. The surrounding skin is soft and healthy.

The **Fungating** or **Exuberant ulcer** is characterized by an excessive growth of granulations which project well above the surrounding skin, bleed freely, and generally appear pale or flabby. There is little or no tendency to cicatrization. Not infrequently this condition is due to the irritation produced by a foreign body imbedded in the granulations, as a ligature or spicule of bone, or to a persistent discharge from some septic focus.

The **Inflamed ulcer** appears red and angry. The base is necrotic, the edges everted and overhanging, the surrounding skin congested and œdematous. The entire region is painful and tender to pressure. The cause may be external irritation, impeded venous circulation, constitutional causes, as gout, eczema, etc., or infection.

The Indolent or Chronic Ulcer.—Any ulcer may become indolent from neglect, impeded circulation, or constitutional causes. These ulcers may occur in any part of the body, but are most frequently seen on the lower legs of elderly people with varicose veins and œdematous tissues. They appear as large unhealthy-looking sores, with thickened purple margins, the central area consisting of an irregular surface of pale flabby granulations, often showing exposed necrotic shreds of fascia, muscle, or bare bone. They have a glazed, dry appearance, and the surrounding skin is thickened, congested, œdematous, pigmented, and occasionally the seat of a chronic eczema.

The Spreading, Phagedænic, or Sloughing Ulcer.—This resembles the inflamed ulcer, but has in addition a tendency to spread rapidly. The base is usually necrotic, the edges greatly undermined, and the surrounding tissues deeply congested. There is usually an abundant thin, foul-smelling discharge. The neighboring lymph-nodes are enlarged and there may be considerable general sepsis. The cause is usually a virulent infection, a depraved constitutional state from disease or dissipation, or both combined.

The Scorbutic Ulcer.—This appears most frequently on mucous membranes, but it may occur also upon the skin. The cause of the necrosis is usually a blood-clot. The destruction of tissue is often rapid and extensive, the base of the ulcer is frequently black or covered with a fibrinous exudate, and there is a marked tendency to bleed on the slightest contact.

The Syphilitic Ulcer.—A late syphilitic ulcer is practically always a necrosing gumma. The base is usually indurated. The surface is generally covered with a white slough at first, which later becomes of a dirty gray color and gradually separates. Under favorable conditions after separation of the slough the ulcer is gradually converted into a healing ulcer, which finally cicatrizes, leaving a depressed scar covered with a thin pearly-white cicatrix which is easily made to wrinkle by pressure on the surrounding skin. Under unfavorable conditions the peripheral induration spreads, the central loss of substance becomes larger and may reach an enormous size. The shape of the ulcer is generally round or oval.

The Tuberculous Ulcer.—This occurs in several forms. The tuberculous *wart*, commonly seen in butchers and in those who handle anatomic material, appears usually on the back of the fingers as an indolent induration which finally ulcerates and slowly spreads to the surrounding tissues.

The tuberculous *gumma* occurs as an indolent bluish-red infiltration of the skin, often in the region of tuberculous lymph-nodes. The lump finally softens, a superficial slough forms, and the mass is discharged, leaving a necrotic undermined ulcer with irregular, corrugated edges surrounded by a purple or bluish infiltration of the skin. Later the cavity fills with unhealthy granulations which secrete a thin, watery pus. There is little tendency to heal.

The most destructive form of skin tuberculosis is *lupus.* While this disease may occur in any part of the body, it attacks by preference the face generally, beginning at the junction of the cheek with the ala of the nose. It is more frequent in women than in men, and occurs, as a rule, in the first or second decade of life. The disease begins by the formation of several small nodules in the corium, which grow slowly, gradually undergo necrosis, and coalesce. As the process first appears on the surface of the skin, there is a small elevated yellowish or brownish area surrounded by a number of soft nodules about the size of the head of a pin. This central area soon breaks down, leaving a shallow, indolent ulcer which furnishes a small amount of purulent secretion, in which tubercle bacilli may be found. As the process extends the peripheral nodules slowly undergo necrosis, and new nodules appear in the surrounding skin. Crusts occasionally form on the surface of the lesion, and in some cases pale granulations appear, and eventually result in slow cicatrization of one part of the ulcer as it extends in another. While the disease in most instances is limited to the skin and subcutaneous tissue, it may extend to muscle, cartilage, and bone, causing extensive destruction of tissue and great deformity.

The **x-ray ulcer** is described on page 173.

Marjolin's Ulcer.—This disease is an epitheliomatous degeneration of a chronic ulcer or of irritated scar tissue. It occurs in old and neglected leg ulcers, in the ulcers associated with multiple fistulous openings about the perineum or ischiorectal region, in chronic ulcers from irritation of the tongue or mucous membrane of the cheek, or in any other tissue of the body where a chronic ulcerative process is subjected to constant irritation from any cause. The malignant change in all probability arises from the fact that certain young epithelial cells become imbedded in the granulation tissue and form a tumor matrix, which later undergoes more or less rapid proliferation.

This change is indicated by a hardening and elevation of the edges of the ulcer, rapid marginal infiltration, a papillomatous appearance of the surface, a tendency to bleed easily, and the occurrence of an increased amount of pain.

The Epitheliomatous Ulcer.—This occurs in two forms. The *small-cell epithelioma* or *rodent ulcer*, which appears first as a warty growth, generally on the face. This later ulcerates and slowly spreads as a round superficial ulcer with a smooth glossy base and slightly elevated, rounded, hard edges. The growth is exceedingly slow, but it never heals. It apparently never involves the lymphatic structures, and if thoroughly removed never returns. It occurs after middle life and is painless. The other variety of epitheliomatous ulcer is the ordinary *squamous cell epithelioma*, which occurs most frequently at the mucous and cutaneous margins. It also is a disease of later life, may occur on skin or mucous membrane, and begins as a warty nodule, an abrasion, or, rarely, as a crack in the mucous membrane of the lip which shows no tendency to heal. The nodule soon ulcerates and presents hard irregular margins with an angry, granular base. The growth is at first slow, but later becomes more rapid and is accompanied by pain. The lymphatic structures are later involved, and the disease is of decidedly malignant character.

The Secondary Malignant Ulcer.—This is formed by the breaking down of carcinomatous and sarcomatous deposits. They extend rapidly, cause extensive destruction of tissue, and constitute one of the most distressing of the terminal symptoms of malignant disease.

Treatment of Ulcers.—In the treatment of ulcers the plan to be followed should be, if possible, to convert the various forms of ulcer into the simple healing variety, the treatment of which will be outlined below. In the case of squamous cell epithelioma, or the secondary ulcers of carcinoma and sarcoma, this can never be accomplished, and the only hope of cure is by early and thorough removal of the disease with the adjacent lymphatic structures. In rodent ulcer and lupus complete excision is undoubtedly the best treatment, and many permanent cures are effected by this method. The frequent location of these diseases on the face, however, will often preclude the possibility of such radical measures, and caustic applications preceded by thorough curetting have been followed by success in the case of rodent ulcers, and antiseptic measures have occasionally been successful in lupus. The use of the *x*-ray, Finsen light, and radium in these conditions has gradually replaced most of the older methods of treatment. For the treatment of rodent ulcer the *x*-ray or radium is to be recommended, for lupus, the Finsen light therapy. In actinomycosis and blastomycosis the internal use of potassium iodide or the copper salts has been found to be of value in combination with local antiseptic applications or the use of radiant energy.

Syphilitic ulcers should be treated by mercurial ointment locally, and by the internal use of mercury and potassium iodide, the latter to be given in progressively increasing doses.

The spreading ulcers, if of septic origin, should be treated with glutol or formalin-gelatin, or thoroughly cauterized with pure nitric or carbolic acid, and afterward treated by a wet carbolic acid or bichloride dressing. Inflamed or varicose ulcers should be kept at rest by placing the patient in bed, and treated at first by hot poultices or a dressing of weak bichloride or carbolic solution until the chronic passive congestion is relieved, the edges softened and more healthy, and the sloughs separated from the floor of the ulcer. After this, granulation should be stimulated by a wet dressing of myrrh wash (1 part of tincture of myrrh to

12 parts of water), or the use of unguentum hydrargyri, half strength. In the exuberant ulcer the cause of the overgrowth should be found and removed, after which the granulations should be cut down to the level of the surrounding skin with scissors, and silver nitrate applied. If the granulations are pale and watery, the application for forty-eight hours of several layers of gauze soaked in glycerin will often cause them to shrink from the withdrawal of fluid, and stimulate them to a healthy growth.

The treatment of a healing ulcer should consist chiefly in what Morris speaks of as a "skilful neglect"—that is, avoiding measures which retard repair, such as irritating dressings frequently changed, excessive movement of the part, and positions which favor active or passive congestion. The part should be kept at rest in such a position as to favor free circulation, especially the return of venous blood. Astringent wet dressings, such as myrrh wash, black wash, or aluminium acetate, are serviceable; also bland ointments, as cold cream, lanolin, white vaselin, or zinc oxide ointment. Strapping the ulcer and surrounding skin with overlapping strips of lead plaster and allowing the plaster to remain in place three or four days, will often be followed by rapid healing. In varicose leg ulcers the use of an elastic stocking or Martin's bandage will improve the circulation and favor cicatrization. Protecting the granulations with gold-beaters' skin or silver foil is to be recommended. Large ulcers which do not heal rapidly should be subjected to skin-grafting (see page 194).

New Growths of the Skin.

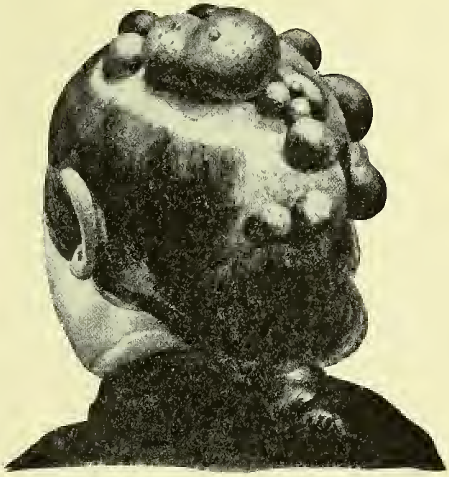
Papillomata, or Warts.—Warts are cutaneous excrescences and consist of a group of hypertrophied papillæ covered with epithelium, forming an oval or conical tumor which varies in size from that of a pin's head to that of an orange. They occur chiefly on the hands, on the penis, and about the female genital organs and the anus. Their growth on mucous surfaces is favored by heat, moisture, and the presence of irritating discharges. From cutaneous surfaces they should be removed by thorough curetting and the application of solid silver nitrate to the resulting wound. From mucous surfaces they may be simply removed with scissors, and the wounds dressed with aristol or other antiseptic powders.

Sebaceous Cysts.—These tumors (Fig. 100) are of fairly frequent occurrence, especially on the scalp. They are encapsulated masses of sebaceous material due to a retention of the secretion of a sebaceous gland. They are round, painless swellings in the skin, and on close inspection a black comedo can generally be seen on the summit of the mass.

Treatment.—The treatment should be by incision to the capsule, and by enucleation by a probe or some other blunt instrument.

Dermoids.—These cysts occur often in the median line of the body or over the situation of the embryonic clefts. The superficial variety, called *atheromatous dermoids*, resemble closely the sebaceous cysts, in that they contain a semisolid cheesy material made up of the secretion of sebaceous glands and maccrated epithelial cells. The deeper varieties often contain hair, teeth, and other tissues. They will be described more at length in other sections.

Fig. 100.



Multiple atheromatous cysts (wens). (Lexer.)

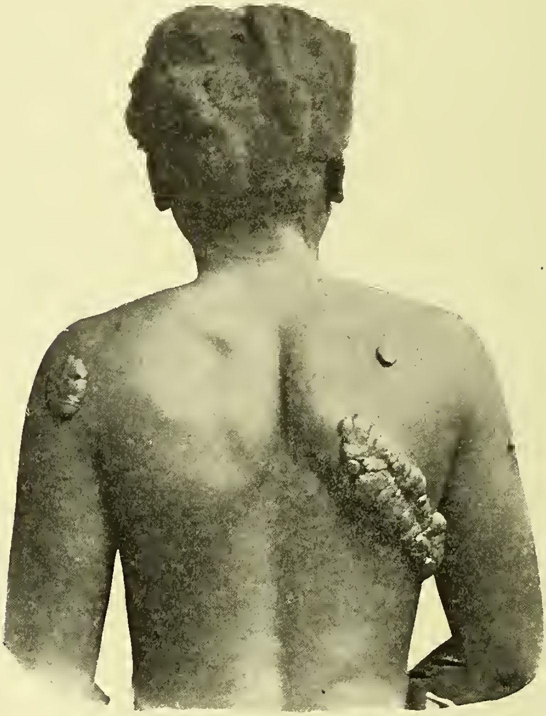
Fibromata.—Fibromata of the skin are of fairly frequent occurrence. The *hard fibromata* are composed of dense fibrous tissue, which in their growth cause a thickening of the surrounding tissues resembling a capsule. These not infrequently arise from the sheath of a cutaneous nerve, the *painful subcutaneous tubercle*, and give rise to more or less severe pain. The *soft fibromata* are made up of areolar tissue and are often pedunculated. These frequently are multiple, develop along the cutaneous nerve trunk, and constitute a condition called *fibroma molluscum*. *Fibroneuromata* are tumors growing from a cut or injured nerve, and contain both fibrous tissue and nerve filaments. *Moles* are fibromata of the skin which are generally congenital, are pigmented, and frequently present a growth of hair on their surface.

These tumors rarely give rise to surgical indications unless they are painful or produce deformity, in which case they should be removed. Care should be taken, however, to remove the entire growth, as partial removal, especially in pigmented moles, is occasionally followed by malignant degeneration.

Keloid.

Keloid is an exuberant cicatrix caused by the development of an abnormal amount of fibrous tissue in and about the scar of a wound or burn. It appears gradually after the complete healing of the wound, and may continue to enlarge for several months. At first the tissue is highly vascular and has a purplish appearance; later it becomes paler and more firm. It occurs with great frequency in the negro race (Fig. 101). Occasionally these growths undergo sarcomatous change.

Fig. 101.



Keloid tumors of back. (Roberts.)

Considerable difference of opinion exists regarding their **treatment.** Some surgeons advise complete removal with careful union of the wound, hoping for primary union with a small scar. Others advise non-interference, for the reason that the secondary scar is liable to be as large or larger than the one removed, and also for the additional reason that surgical interference occasionally seems to favor the development of malignant changes. The hypodermic use of thiosinnamine is said to produce shrinkage in the keloid tissue in certain cases.

Carcinoma.—This occurs as a primary growth in the skin, *epithelioma;* as a secondary involvement from some adjacent organ; as a degenerative process engrafted on some benign skin lesion, as an ulcer, wart, or mole; or, very rarely, as a metastatic deposit, which may be single or multiple.

Epithelioma has already been considered earlier in the chapter, and the general features of carcinoma have been discussed in Chapter IV.

Sarcoma.—Primary sarcoma of the skin is exceedingly rare; sarcomatous degeneration of a fibroma is more frequently observed. This change occurs commonly in pigmented moles.

Secondary sarcomatous deposits in the skin are not infrequent. If the primary growth is a melanotic sarcoma, the secondary nodules will contain pigment.

Idiopathic multiple hemorrhagic sarcoma has been described, also *sarcomatosis cutis.* These diseases are characterized by the development of multiple small sarcomatous lesions over large areas of the body. In the former condition the lesions are dark red or purple in color and may resemble angiomata; in the latter the lesions exhibit no pigment or unusual vascularity.

In the *treatment* of malignant growths of the skin the same principles should be followed as in other tissues.

Early radical removal constitutes the best treatment, when the disease can be completely eradicated. In the various secondary and metastatic lesions this plan is obviously impracticable, and palliative measures are to be recommended. The *x*-rays or radium will often be of service in these cases, and in the sarcomata the use of Coley's fluid is to be advised.

Keen has recently emphasized the fact, which is not yet fully appreciated by the profession, that warts and moles when subjected to more or less constant irritation are prone to undergo malignant change, and should be removed before malignant degeneration has occurred.

When the irritated lesion is a papilloma, epithelioma is produced; when a mole, either carcinomatous or sarcomatous transformation may occur.

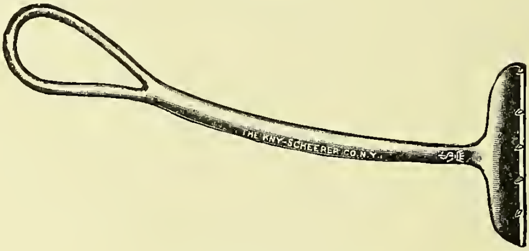
When, after a long period of quiescence, one of these lesions begins to grow, malignant change has probably occurred and demands prompt radical treatment.

Skin-grafting.

Skin-grafting is employed to hasten the healing of large ulcers, and consists in removing portions of epidermis from the inner aspect of the arm or thigh, and planting them on the healthy granulations of an ulcer. The ulcer and surrounding skin, as well as the skin of the part from which the grafts are to be taken, should be rendered aseptic by the usual process. The granulations, if exuberant, are to be curetted to the level of the surrounding skin; hemorrhage should be checked by sponge pressure and hot irrigation with normal salt solution.

Reverdin's method consists in cutting small pieces of epidermis from a healthy part by scissors and placing them on the ulcer, the cut surfaces being in contact with the granulations. In *Thiersch's method*, long strips of epidermis are cut with a razor from the inner side of the thigh or arm, and carefully laid upon the ulcer in such a manner as completely to cover it. Considerable skill is required to cut these strips, which should be exceedingly thin, and are best cut while the skin is on the stretch by being drawn upward and downward with the edge of a narrow board, or by McBurney's hooks (Fig. 102). When the grafts are in place they are covered with several overlapping strips of rubber protective tissue and surrounded by several thicknesses of sterile gauze wet with normal salt solution, and the whole held in place by a bulky dressing of cotton and a snug bandage. The rubber tissue should, if possible, be left in place for a week or ten days. After a successful grafting the granulations will be covered with a delicate bluish transparent epidermis, which soon spreads over the entire ulcer and gradually thickens. In the subsequent dressings the rubber protective should be used until the grafts appear vigorous, after which any simple sterile dressing will answer.

Fig. 102



McBurney's hook.

Halsted has suggested the use of silver foil in place of rubber tissue in the primary dressing.

Wolfe Grafts.—The use of grafts made by transplanting sections of the entire skin may be necessary in case of marked cicatricial deformity, on account of the fact that in these cases the Thiersch grafts show a tendency to contraction and produce a recurrence of the deformity. This method was first suggested by Wolfe, of Glasgow, who first employed it for the relief of ectropion. It has been extensively employed in other localities, as about joints and over exposed tendons.

The cicatrical tissue should first be completely removed and the hemorrhage checked by hot compresses and pressure. An area of healthy skin somewhat larger than the denuded area is next dissected from the thigh or arm and transferred to the original wound. This is held in position by a few sutures, and the wound dressed as after the Thiersch graft. It is desirable to allow the primary dressing to remain in place for from six to ten days, and when dressed to disturb the graft as little as possible, as the early vascular connections are extremely delicate and easily ruptured.

This method has not been as successful as the others, and for that reason is rarely used. Dowd has, however, reported a series of cases where he obtained success in over 90 per cent. of his operations.

CHAPTER X.

INJURIES AND DISEASES OF THE HEART, PERICARIUM, AND BLOODVESSELS.

Traumata of the heart and pericardium are exceedingly rare. When they occur they are generally the result of stab wounds, gunshot wounds, or injuries caused by fractures of the ribs or sternum.

Rupture of the Heart.

Rupture of the heart may occur spontaneously or during some severe muscular strain. As a rule, the predisposing cause is a marked degeneration of the heart muscle from acute disease or from anæmia, the result of obstruction or obliteration of the coronary artery.

The symptoms are the same as in a wound of the heart.

Treatment is rarely indicated on account of the condition of the patient, and for the fact that in a degenerated heart sutures would not hold.

Wounds of the Heart.

Fischer, in 1867, collected 452 cases of wound of the heart. From an analysis of these cases he concludes that from 7 to 10 per cent. of the cases recover; that wounds of the ventricular portion of the heart are more common and less fatal than wounds of the auricular portion; that the right ventricle is more frequently injured than the left; but that wounds of the left are less fatal than wounds of the right ventricle, presumably from the greater thickness of its walls and the arrangement of its muscular fibres, which would tend to effect closure of a small wound by their contraction.

Death following wounds of the heart may be due to rapid loss of blood, to extreme pressure on the organ by distention of the pericardium with blood—the so-called *tamponade* of the heart, which prevents the flow of blood from the vena cava into the auricle, practically arresting the circulation, although the heart may continue to pulsate, or to injury of some of the sympathetic ganglia. Kronecker described a co-ordination centre situated on the interventricular septum, which, if injured, would cause sudden stoppage of the heart.

The **symptoms** of a wound of the heart are shock, dyspnœa, rapid and irregular heart action, and the evidences of a rapid or gradual distention of the pericardium. The situation of the wound and the direction of the injuring force will also help to establish the diagnosis. Occasionally death immediately follows such an injury, presumably due to involvement of the co-ordination centre. Generally, however, death is delayed a few hours or even days.

The **treatment** of cardiac wounds was until quite recently only expectant, most surgeons agreeing with Billroth that any attempt at suture of the heart-muscle was unjustifiable. Recently, however, a number of successful cases of heart suture have been reported which demonstrate that the operation is not attended with great danger, and that the results of such treatment are far in advance of those obtained by the older and more conservative methods. Hill, of Montgomery, Ala., reported 38 cases of heart suture, with 13 recoveries, a mortality of 63 per cent. Wolff and Rickets have since then published additional cases, so that at the present time more than 100 cases of heart suture are on record, with a mortality of about 60 per cent.

Elsberg, from a large number of experiments on rabbits and dogs, concludes that in closing wounds of the heart interrupted silk sutures should be employed, introduced and tied if possible during diastole, and that they should penetrate the epicardium and a part of the heart-muscle. Hill advises catgut rather than silk.

The pericardium can be exposed by a resection of a portion of the fifth rib and costal cartilage on the left side, or, as practised by Minni in his case, by a flap made by joining two horizontal incisions in the third and fifth intercostal spaces by a vertical one along the left border of the sternum, and reflecting this flap containing the fourth and fifth ribs to the left. The pericardium should be freely opened and emptied of clots, and the suture applied while steadying the heart with the hand or with forceps, after which the pericardium should be partly sutured with drainage. If possible, it is desirable to tie the sutures during diastole. If tied during systole they are apt to tear out when the heart muscle relaxes. The left pleura, which is usually opened by either of these procedures, should, if possible, be sutured unless there is reason to believe that it was infected by the original injury. If this has occurred, it should be drained.

Wounds of the Pericardium.

Wounds of the pericardium are often accompanied by wounds of the pleura and lung, and symptoms of the latter (pneumothorax, hæmatothorax) may obscure those due to injury of the pericardium. In the absence of hemorrhage into the pericardial sac, early symptoms of this injury may be wanting. Generally, however, there is a certain amount of shock with irregularity and weakness of the heart action. Later, if the wound is infected, symptoms of *suppurative pericarditis* may develop, as precordial pain, dyspnœa, a rapid, intermittent, and weak pulse, irregular fever, and general physical prostration. Friction-sounds will be heard on auscultation, and, if the wound remains open, a persistent purulent discharge may occur. If the wound has closed, there will be evidences of pericardial fluid, with chills and a marked leucocytosis.

The **treatment** of pericardial wounds, if uncomplicated, should consist in thorough disinfection and drainage. If necessary, the superficial wound should be enlarged and the pericardial cavity irrigated with normal salt solution. If the wound is extensive, it may be partly sutured; if of small size, gauze drainage to the pericardial opening will be all that is required. If pericarditis develops, an ice-bag to the precordial region, strychnine, and digitalis are indicated, with aspiration if a serous exudate distends the sac. If suppuration is present, incision and drainage are to be recommended.

Wounds of the Bloodvessels (see Hemorrhage, Chapter VII.).

DISEASES OF THE BLOODVESSELS.

Acute Arteritis.

Inflammation of one or more coats of the arteries may be due to a variety of causes. Acute infective arteritis may arise from extension of an infective process from the surrounding tissues to the artery itself, resulting in a round-cell infiltration of the vessel-walls, with softening and necrosis, a condition often giving rise to secondary hemorrhage in suppurating wounds; or the process may arise from the interior of the vessel from the deposit of infected thrombi, as seen in pyæmic processes, and as the result of ulcerative endocarditis.

Chronic Endarteritis.

Chronic endarteritis is a slowly developing inflammatory process beginning in the interior of an artery and extending to the media and adventitia. It occurs in two forms, the atheromatous and the obliterative.

In the **atheromatous** variety there is at first a circumscribed round-cell infiltration of the intima and media, which later undergoes fatty degeneration, forming a pultaceous mass which may separate, leaving a loss of substance on the interior of the vessel, called an atheromatous ulcer. This causes a weakening of the vessel-wall at that point, which may later dilate and form an aneurism, or the ulcer may be covered by a calcareous plate. A plate of this kind may subsequently become loosened and be carried away by the blood-current, forming an embolus, or the blood may find its way underneath it and eventually separate the coats of the artery and form a dissecting aneurism. A compensatory thickening of the adventitia often occurs in these cases, preventing the formation of an aneurism. Atheromatous endarteritis occurs chiefly in the aged, and in those who have suffered from syphilis, nephritis, or the abuse of alcohol. It affects chiefly the larger arteries.

In the **obliterative** form the infiltration of the intima is more uniform, and causes a gradual diminution in the lumen of the vessel with final obliteration. This occurs more commonly in the smaller vessels, and is generally due to syphilis.

Fatty Degeneration.

Fatty degeneration of the intima may occur independently of atheroma and occasion a weakening of the vessel.

Calcification of the Media.

Calcification of the media occurs in old people, and renders the arteries rigid and narrow. It is most frequently observed in the vessels of the extremities, chiefly at the points of departure of the principal branches. It causes impaired nutrition of the parts, often terminating in senile gangrene.

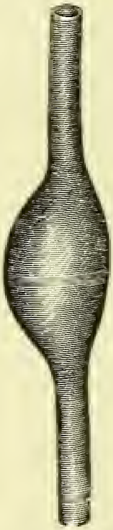
Aneurism.

An aneurism is a pulsating hollow tumor filled with blood, communicating with the interior of an artery. Two varieties are commonly described: the *true* or spontaneous aneurism, and the *false* or traumatic aneurism. A true aneurism is one in which the walls are formed by one or more of the coats of the artery, and is in reality a dilatation of the vessel; a false aneurism is one in which the walls are formed by the surrounding perivascular tissues thickened by blood-clot and inflammatory exudate, and is due to rupture of the vessel.

Causation.—Two factors may be present in the production of a true aneurism: an increase in the blood-pressure and a weakening of the arterial wall. The causes which increase blood-pressure are mental or physical strain, the abuse of alcohol, hypertrophy of the heart, and renal disease; those which weaken the arterial wall are trauma, acute arteritis, atheroma, gummatous infiltration, or obliterating endarteritis of the vasa vasorum. Thus, true aneurisms occur most frequently between forty and sixty, the period of life when physical and mental strain are apt to be greatest, while the heart action is still vigorous, and when degenerative changes begin to occur. For obvious reasons they are more frequent in men than in women. Syphilis, alcoholism, renal disease, and gout undoubtedly act as predisposing causes.

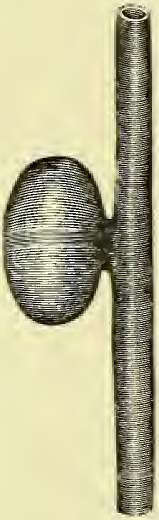
Development and Varieties of Aneurism.—As a result of increased blood-pressure a portion of one of the larger arteries which has become weakened by atheromatous changes or from any other cause shows a tendency to dilate. The dilatation slowly progresses at first, and may involve the entire vessel, giving rise to a spindle-shaped swelling or *fusiform* aneurism (Fig. 103). If only one portion of the arterial wall gives way, a pouch-like protrusion occurs, forming a *sacculated* aneurism (Fig. 104). If an atheromatous ulcer forms or if the intima is eroded by the separation of a calcareous plate, the blood dissects its way between the arterial coats and forms a *dissecting* aneurism (Fig. 105), the cavity

FIG. 103.



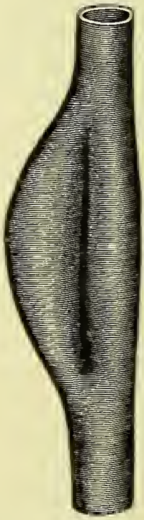
Fusiform aneurism.

FIG. 104.



Sacculated aneurism.

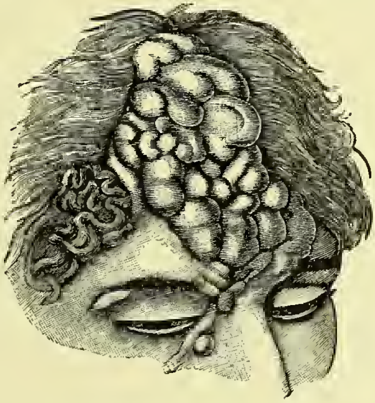
FIG. 105.



Dissecting aneurism.

of which many communicate with the lumen of the artery at one or two points. Aneurisms occasionally result from the plugging of small terminal arteries by emboli. The dilatation and elongation of an artery or of several arterial branches forming a pulsating mass is spoken of as a *cirsoid* aneurism (Fig. 106).

Fig. 106.



Cirsoid aneurism. (Burns.)

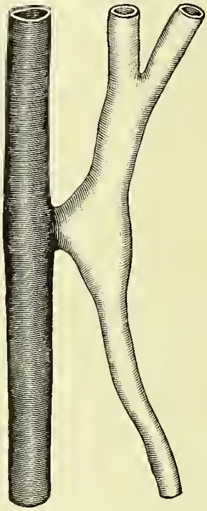
Minute *miliary* aneurisms occasionally form on the arterioles, especially in the pia mater, and by their rupture give rise to apoplexy.

False or *traumatic* aneurism is generally the result of a wound of an artery or of rupture of a true aneurism. If as a result of an injury, as a stab or gunshot wound, an arterial trunk is injured, blood is poured out, and a hæmatoma forms around the vessel. If the resistance of the surrounding tissues is such as to prevent a wide diffusion of the extravasated blood, the peripheral portion coagulates, forming a kind of sac which is later strengthened by an inflammatory exudate. If the wound in the vessel is not occluded by a clot, fluid blood from the artery is continually pumped into the hollow centre of the mass, forming a gradually increasing pulsating tumor. If the injury wounds not only an artery but also a neighboring vein, the blood may pass from the artery directly into the vein, forming an *arteriovenous* aneurism. Two varieties of arteriovenous aneurism exist: one, in which the union between the injured vessels is close, called an *aneurismal varix* (Fig. 107); the other, in which the blood passes from the artery into a false aneurism and then into the vein, which is separated from the artery by the aneurismal sac, called a *varicose aneurism* (Fig. 108).

In all aneurisms there is a tendency to gradual increase in size. In true aneurisms the intima and media frequently become atrophied, while the adventitia thickens and occasionally makes up the entire wall of the tumor. As the aneurism enlarges a deposit of fibrin takes place on the interior of the sac, giving rise to great thickening of the walls. This deposit is laminated, and in rare cases develops to such an extent as finally to occlude the vessel and result in spontaneous cure. Spontaneous cure is also rarely effected by a blood-clot or the separation of a mass of fibrin from the walls of the sac, which plugs the outlet or the vessel beyond the tumor. Spontaneous cure may also take place in false aneurisms and in the arteriovenous varieties.

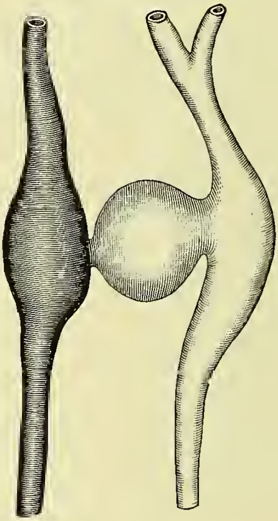
The growth of an aneurism will cause great destruction of neighboring tissues. The more resisting tissues, as bone and cartilage, suffer more, as a rule, than the softer and more yielding structures.

Fig. 107.



Aneurismal varix.

Fig. 108.

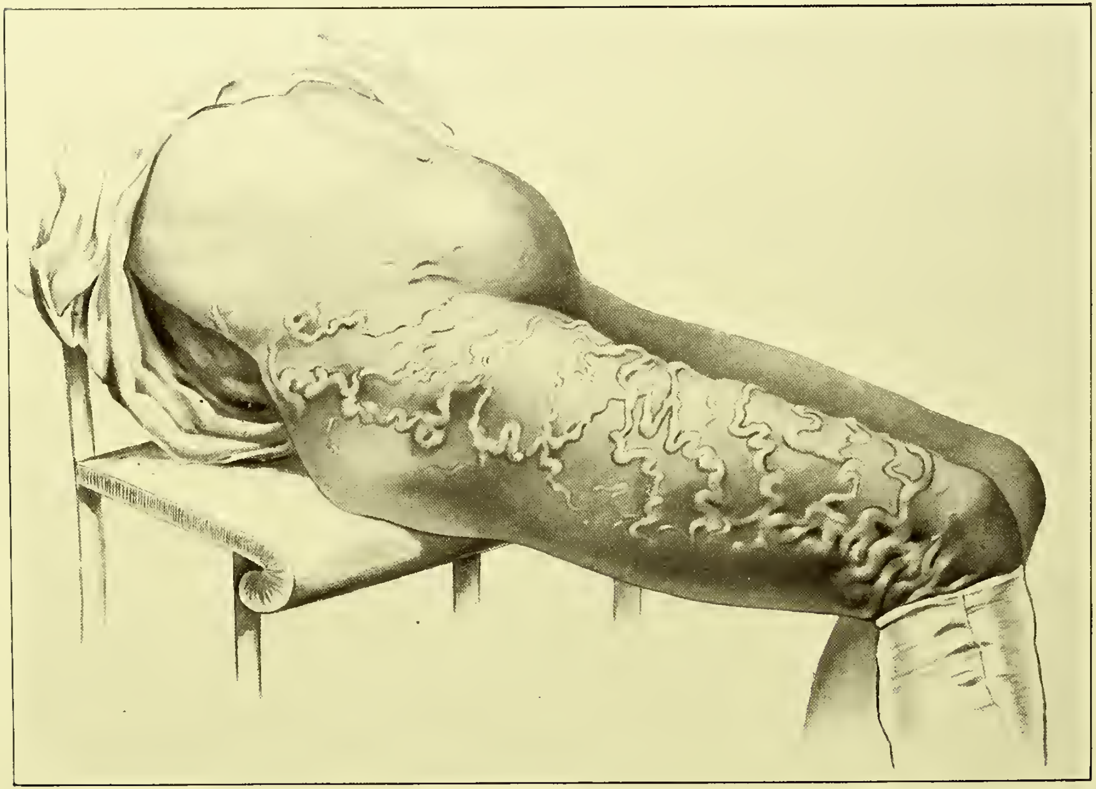


Varicose aneurism.

Thoracic aneurism not infrequently causes erosion of the spinal column and pressure on the cord, as well as bulging and atrophy of the sternum and ribs. Rupture of an aneurism may occur, and suppuration has been observed, generally the result of infection of a wound from distal or proximal ligature.

Diagnosis.—The early symptoms complained of by patients suffering from aneurism are usually only a swelling and a disagreeable sense of throbbing over the region of an arterial trunk. Later, as the tumor enlarges, there may be more or less pain, and if the aneurism presses upon and erodes bone, the pain may be very severe. On examination a tumor is found which pulsates

PLATE IV



Arteriovenous Aneurysm (Femoral). Sacculated Aneurysm (Iliac).

synchronously with the heart. The tumor is, as a rule, oval, elastic, and gives one the feeling that it contains moving fluid. If the interior of the tumor is largely filled with fibrin, pulsation may be faint and palpation may give the impression of a solid mass. As a rule, the tumor expands in every direction with each heart systole, and if grasped between the fingers or hands in any diameter expansile pulsation will be felt. Aneurisms, as a rule, are compressible. If steady pressure is made with the hand over the tumor, the size will be markedly diminished, and when the pressure is removed it will take several beats of the heart to regain its previous dimensions. Pressure over the main arterial trunk, between the tumor and the heart, will cause the pulsations to cease and the tumor to shrink, while pressure over the efferent portion of the artery will cause it to increase in size. The pulse in the arteries beyond the aneurism will be weaker and the beat somewhat retarded if comparison is made with a corresponding artery on the other side of the body. If the tumor is examined by the ear or stethoscope, a blowing sound will often be heard synchronous with the pulse, which is transmitted in the direction of the vessel. This aneurismal *bruit* is loudest in the fusiform variety and may be absent in some sacculated aneurisms. As the aneurism increases in size pressure-symptoms generally arise, such as neuralgic pains, sensory and motor paralysis from pressure on nerves, venous congestion and œdema from pressure on veins, various visceral disturbances from pressure on organs, as dyspnœa and aphonia from pressure or erosion of the larynx or trachea, dysphagia from the pressure of a thoracic aneurism on the œsophagus, cerebral symptoms from the pressure of an intracranial tumor.

It is often difficult to distinguish between false and true aneurisms. *False* aneurisms are rarely fusiform, and are often somewhat irregular in outline. Pulsation may be absent, or it may be much more distinct in one portion of the tumor than in another. The bruit is rarely as well marked as in true aneurisms.

In *arteriovenous* aneurisms there is usually marked dilatation of the veins in the neighborhood of the injury, and an exceedingly loud, harsh bruit can be heard over the entire region, which, if situated near the head, is extremely distressing to the patient. The dilated, tortuous veins may form a large pulsating mass, easily compressible and imparting a distinct thrill to the hand when palpated (Plate IV.)

Cirsoid aneurism may appear as a single tortuous pulsating arterial trunk frequently seen on the scalp, producing no symptoms; it may consist of several dilated arteries, forming a pulsating mass; or the vascular dilatation may extend to the capillaries and venules. In these conditions a tumor is present which is somewhat irregular in outline, may be bluish in color, is pulsating, compressible, and presents a loud bruit on auscultation. Dilated vessels can often be seen running into the mass. This condition is often spoken of as *pulsating angioma.*

Rupture of an aneurism externally produces generally a rapidly fatal hemorrhage; rupture into one of the body cavities produces localized pain and the symptoms of concealed hemorrhage; shock, pallor, cold perspiration, rapid and feeble pulse, air-hunger, and syncope; rupture of an aneurism into the solid tissues of a part produces severe lancinating pain, sudden disappearance of the original tumor, and the appearance of a diffuse swelling in the neighboring tissues, with coldness and œdema of the parts supplied by the artery and an absence of the pulse in the distal branches.

Suppuration of an aneurism is indicated by the local and general signs of inflammation.

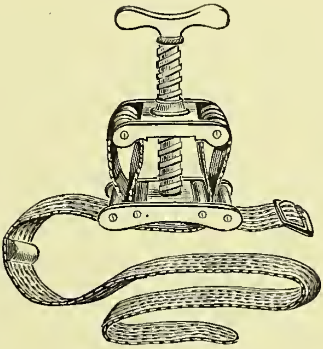
Treatment.—In the treatment of aneurisms an effort should be made to favor nature's method of cure, which is by the formation of a firm fibrinous occluding mass within the sac. This may be accomplished by lowering the blood-pressure and by diminishing the amount of blood which flows through the sac. Failing in this the disease may be cured by entirely cutting off the circulation through the diseased artery with or without extirpation of the tumor.

Non-operative Methods.—Absolute rest in bed combined with an exceedingly low diet, consisting of 2 or 3 ounces of meat, 6 ounces of bread, and 6 ounces of milk or water each day; and the use of aconite and potassium iodide, will undoubtedly produce a marked lowering of the blood-pressure and a diminution in the force and frequency of the heart-beat. This treatment should be continued for several weeks or months, and during this period the patient should be kept free from any mental or emotional excitement. The wearing of a moulded lead plate weighing two or three pounds, made accurately to fit the tumor, if practicable, will often prove of great value when combined with rest and low diet. In aneurisms of the extremities moderate pressure over the tumor may be maintained by the use of a rubber bandage. This with elevation of the limb will occasionally succeed in arresting or curing the disease.

Treatment by *proximal arterial pressure* has long been favorably considered by the profession, and many cases have been cured by it. It is, however, applicable to only a limited number of cases. The plan is to cause constant pressure upon the artery at some distance above the tumor. The pressure should, if possible, be such as to include the artery but not the vein, and to produce noticeable cessation of pulsation in the tumor. If the circulation through the sac is entirely cut off, the cavity will rapidly fill with an ordinary red clot of blood. If a small amount of blood is allowed to flow through the aneurism, a firm white fibrinous clot will form more slowly, but will be much more likely to remain and produce permanent occlusion of the cavity when the pressure over the artery is relaxed.

The methods of arterial compression are two, the *digital* and the *instrumental.* The digital is in every way superior to the instrumental, on account of its accuracy, the ease with which it is regulated, and the fact that the vein can generally be avoided and injury of the tissue prevented. Relays of assistants are necessary, and when changing, the pressure of the relieved assistant should not be relaxed until the thumb of the relieving assistant is in place. The mechanical means of arterial compression are by the use of the Petit tourniquet (Fig. 109). Two of these should be kept in place, and the pressure point changed every few hours. The use of mechanical apparatus for this purpose is extremely painful, and often requires general anæsthesia. During the progress of this treatment the pressure should from time to time be gradually relaxed to determine the condition of the tumor. When, after relaxing the compression, pulsation is found to be absent, the outlook is favorable. The pressure should, however, be continued to a moderate degree for from twenty-four to forty-eight hours more.

Fig. 109.



Petit's tourniquet.

Violent massage or manipulation of the tumor, with a view to dislodging a portion of the laminated fibrin to cause a plugging of the outlet, is to be condemned as a dangerous procedure.

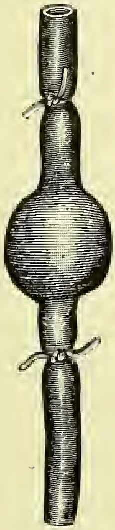
Forcible flexion of the knee or elbow for the cure of small aneurisms situated in these regions has been successful in a number of instances. The effect of the flexion is to occlude the vessel and to produce direct compression on the aneurism, causing rapid clotting of the contained blood. If the limb is held in a position of extreme flexion, the blood-current is entirely arrested. If the flexion is of moderate extent, the blood-current may only be retarded, favoring the formation of a firm fibrinous mass within the sac. It is desirable to bandage the limb below the tumor, and after flexion to maintain the position by means of straps, bandages, or an elastic apparatus. Every few hours the flexion should be temporarily relaxed to determine the condition of the tumor. This method should never be employed in large or thin-walled aneurisms, for fear of rupture.

Operative Methods.—Complete extirpation of the aneurism with ligature of all the branches and closure of the wound, with a view to obtaining primary union, is the method of choice when it can be safely carried out. It is applicable to all accessible small aneurisms, and in many of the larger ones which can be freely exposed. The chief difficulty experienced in carrying out this plan is in separating the tumor from the neighboring structures, to which it is generally attached by firm adhesions. Extirpation of a portion of the main venous trunk is often necessary on this account, but its removal is rarely attended with serious symptoms, as the pressure of the tumor has, as a rule, already caused the venous circulation to be carried on by other channels. If large nerve-trunks or other important structures are in danger of being injured, a portion of the sac may be left.

The method is to expose the tumor by a long incision which extends above and below sufficiently to give a good exposure of the vessels. The artery above and below the tumor should be double ligated and cut (Fig. 110). The aneurism is then dissected from its bed and other branches, if found, double ligated, and divided. Considerable bleeding may occur from the separated adhesions, which should be controlled by ligature, hot water, or hydrogen peroxide, after which the wound should be closed and a dressing applied. In the extremities a splint or stiff bandage should be used to insure absolute rest of the part. In large or thin-walled aneurisms it is often desirable to perform the operation in two stages: first, ligation of the main artery above the aneurism to produce clotting within the sac and diminution in the size of the tumor, and at a later period to remove the sac. This method is undoubtedly safer than to perform the operation while the tumor is tense and liable to rupture, and when all the connecting arterial branches are open and pulsating.

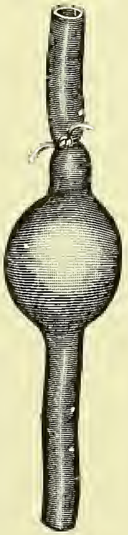
Proximal ligature is perhaps the method most generally employed at the present time for the cure of aneurisms. Ligature just above the tumor with a view to cutting off the circulation entirely, the method of Anel (Fig. 111) is often employed; but when possible ligature at some distance above the tumor (Fig. 112), the method of Hunter, is to be preferred, as in this operation the circulation is rarely completely arrested and the danger of immediate gangrene is less. Moreover, the artery at this distance above the aneurism is less likely to be diseased and secondary hemorrhage is thereby avoided. The effect of proximal ligature upon an aneurism is the same as compression of the artery; the blood-current is either completely arrested or the flow very much diminished. In the former instance a red clot forms at once in the sac, in the latter a laminated fibrinous clot forms slowly and eventually fills the cavity. In either case pulsation ceases in the tumor; it becomes firmer and gradually diminishes in size. Halsted has recently advocated partial obliteration of the lumen of the vessel by means of flat metal bands. The nutrition of the parts supplied by the artery will depend upon the possibilities of the collateral circulation and the degree to which the anastomosing vessels have been dilated by the obstruction caused by the aneurism. Generally the pulse below the tumor is immediately obliterated, the parts become anæmic and cool, and sensation may be impaired. The circulation, however, is gradually restored, the parts become warmer, and the capillary circulation more active, as evidenced by a more rapid return of the normal pink color of the

FIG. 110.



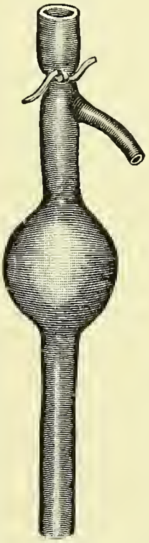
Double ligature.

FIG. 111.



Proximal ligature. (Anel.)

FIG. 112.

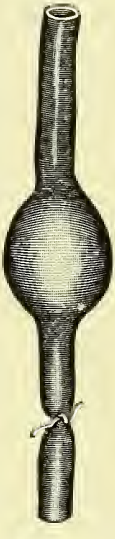


Proximal ligature. (Hunter.)

nail or extremity of the finger or toe after pressure, and a feeble pulsation can be felt in the distal branches. When the collateral circulation is insufficient, the part remains cold and lifeless, and gangrene, generally of the moist variety, develops.

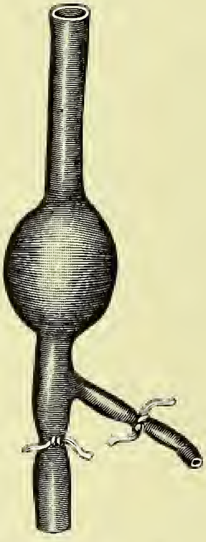
Distal Ligature.—Proximal ligature is often impossible on account of the situation of the aneurism or its nearness to an important trunk. In these instances distal ligature is resorted to with a view to arresting the circulation and forming a clot within the sac. The method is inferior to the proximal ligature, and should only be employed when proximal ligature is impossible. Two methods are in use: ligature of the main trunk beyond the tumor, and ligature of one or more branches issuing from the main trunk. The former is known as the method of Brasdor (Fig. 113); the latter, as that of Wardrop (Fig. 114).

Fig. 113.



Distal ligature. (Brasdor.)

Fig. 114.

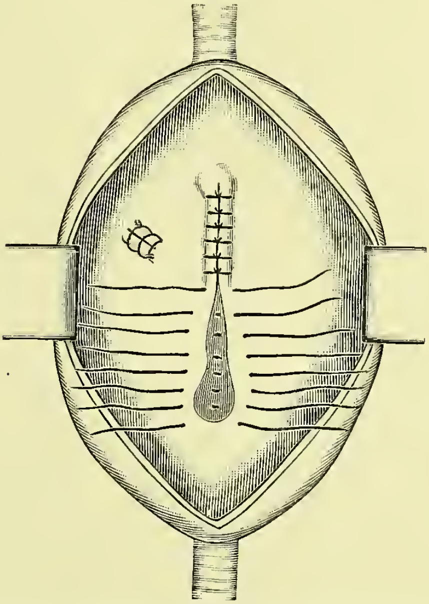


Distal ligature. (Wardrop.)

After any operation in which the main arterial trunk of an extremity is ligated, the limb should be wrapped in cotton batting and bandaged without pressure, external heat applied, and the limb elevated to favor return venous circulation. If gangrene appears, amputation should be resorted to, generally above the point of ligature.

A method of radically treating aneurism has recently been suggested by Rudolph Matas. Recognizing the ready adhesion of sutured serous surfaces, he advises, after compression of the main supplying arterial trunk, incision into the aneurismal tumor, removal of the clots and fibrin, and closure of the arterial orifices by sutures so placed as to insure broad approximation of the margins of the openings (Fig. 115). In sacculated aneurisms he closes the single orifice of communication between the artery and aneurismal sac and thus restores the main vessel (Fig. 116). In certain fusiform aneurisms he constructs a new channel by suturing the walls of the sac over a rubber catheter, in the same manner as the Witzel method of gastrostomy is carried out, removing the catheter, however, before the last suture is tied (Fig. 117). After all of these procedures he obliterates the remaining portion of the aneurismal cavity by closely approximating its walls by suture. After this is accomplished, the wound is tightly closed and an aseptic dressing applied. He claims that this method is safer than the older procedures, the wounds heal more promptly, and in some instances the artery is restored to its original dimensions.

Fig. 115.



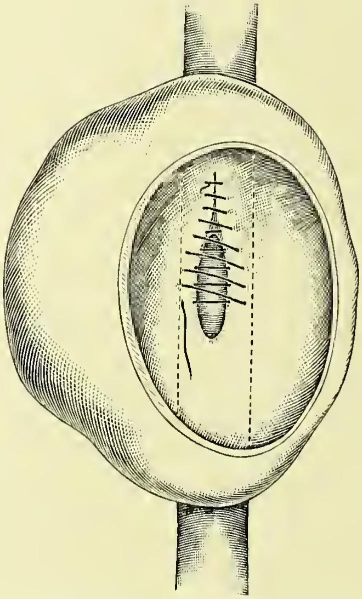
Shows the orifices in the aneurismal sac in process of obliteration by suture. The first plane of sutures may be made with fine silk, but chromicized catgut is preferable. The sutures are applied very much like Lembert sutures in intestinal work; the first plane of sutures should be sufficient to secure complete hæmostasis.

The orifice of the collateral vessel on the left upper side of the sac is shown closed by three continuous sutures.

Other methods of treatment looking to the formation of a clot or fibrinous deposit within the sac of an aneurism have been suggested from time to time and practised with varying degrees of success.

Acupuncture.—Introducing a number of needles into the sac of an aneurism and allowing them to remain ten or twelve hours has occasionally been followed by the formation of firm coagulation within the sac, and cures have been reported.

FIG. 116.



Shows the sac of a sacculated aneurism opened. The dotted lines indicate the position and relations of the main artery to the sac and to the orifice of communication. The object of the operation in this case is to close the orifice of communication without obliterating the main artery. The closure of the orifice with continued suture is shown in the figure.

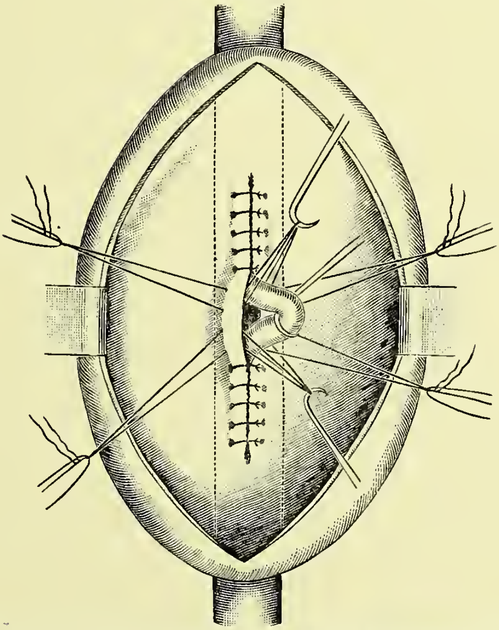
The *introduction of large masses of silver, gold, platinum,* or *steel wire* into an aneurism through a minute canula has been successfully employed in a number of cases.

Galvanopuncture, by introducing two fine insulated steel needles into an aneurismal sac and allowing a galvanic current from ten to twelve cells to pass through the contained blood, will often cause the rapid formation of a firm fibrinous mass.

A combination of these two last methods has of late been quite extensively employed. Willard has recently reported 24 cases treated in this manner, 10 of which were positively benefited, and all were apparently rendered more comfortable by the treatment. The method consists in introducing through a fine insulated canula from 15 to 20 feet of fine silver or gold wire previously wound upon a spool to insure its curling up within the sac, and to pass through this for one hour a current of from 5 to 80 milliampères, the positive pole being connected with the wire, the negative applied by means of a sponge to the back of the patient.

The *gelatin treatment* recommended by Lancereaux is at present undergoing trial. It is recommended for large inoperable sacculated aneurisms. It consists in the subcutaneous injection of a 1 per cent. solution of gelatin in normal salt solution. This should be repeated once a week and combined with rest in bed and measures to reduce the blood-pressure. The objections to the method are the great difficulty in sterilizing the gelatine—a number of cases of tetanus having followed its use; and the fact that marked renal irritation is often developed. Sorgo reports a number of cases, but is unable to explain the manner in which the results were obtained. Connor believes the favorable results are due to the rest and low diet. These methods are only to be recommended in cases in which extirpation, proximal ligation, or the Matas method cannot be carried out.

Fig. 117.



Shows method of creating a new channel in a fusiform aneurism. The sutures are nearly all tied, and the new channel is completed except in the centre. The two upper sutures are hooked and pulled out of the way while still in position, and the catheter withdrawn.

INJURIES AND DISEASES OF THE VEINS.

Injuries of the veins and their treatment have been considered under Hemorrhage, in Chapter VII.

Phlebitis.

Phlebitis is an inflammation of one or more coats of a vein. Two varieties are described, the *plastic* or non-suppurative, and the *infective* or suppurative variety. Plastic phlebitis is said to result from trauma, gout, rheumatism, and other debilitating constitutional conditions. It is probably due in the majority of cases to the action of pathogenic micro-organisms, the virulence of which is not sufficient to excite the ordinary evidences of inflammation. The intima of the vein becomes thickened or eroded, a *thrombus* forms at the site of the lesion which eventually fills the lumen of the vein and may extend upward or downward for a considerable distance. This condition of *thrombosis*, when it occurs in a large venous trunk, greatly interferes with the return venous circulation and gives rise to œdema of the extremity or part below the lesion. The thrombus may become organized and converted into firm connective tissue which permanently plugs the vessel ; it may become calcified (phlebolith) ; or it may become canalized by the dilatation of the new capillaries formed within the organized thrombus or a coalescence of small spaces or vacuoles which form during contraction of the clot. If the lumen is restored, the circulation goes on as before ; if it is permanently occluded, the free venous anastomosis soon forms compensatory channels.

Infective or Suppurative Phlebitis.—This practically always results from some acute inflammatory process in the neighborhood of the vein, generally a cellulitis or infected wound. The process may begin from without and involve all the coats of the vein, or from within by infection conveyed through the blood. There is usually a marked round-cell infiltration of the entire vein. A thrombus forms as in plastic phlebitis, but soon breaks down, forming a purulent mass, which may give rise to local abscesses along the course of the vein, or infective thrombi which are carried to various parts of the body and by their lodgement give rise to secondary suppurative lesions (pyæmia).

Diagnosis.—The symptoms of plastic phlebitis are simply a thickening of the vein and a certain amount of œdema below the lesion. If the vein is a small one and anastomosis is free, œdema may be wanting. If the vein is a large one, as the femoral, œdema may be marked, increasing the circumference of the limb to double its normal size. This continues for from two to six weeks and then gradually subsides. There is, as a rule, no pain, only a feeling of numbness and weight. Fever may be present, but is usually of moderate degree. In the suppurative variety the vein and perivascular tissues become thickened, hot and tender, the overlying skin reddened and œdematous. Fever is present, often accompanied by chills and sweats. If a large trunk is involved, œdema may occur as in the plastic variety. Later, suppuration occurs in several places along the vein, or the symptoms of general sepsis with metastatic abscesses develop.

Treatment.—In the plastic variety with thrombosis of a large trunk and œdema, absolute rest in bed should be advised, with slight elevation of the limb to favor return venous circulation and the application of a moderate degree of heat by means of well-protected hot-water bags. Active movements of the extremity, massage, or any handling of the region of the thrombosed vein, should be avoided on account of the danger of dislodging a portion of the clot. In the infected variety wet dressings should be applied to the infected region and the abscesses opened and freely drained. It is often advisable in the early stages of a septic phlebitis to ligate the vein above and below the thrombus, open and remove the infected mass. If this can be carried out early, metastasis and general sepsis may often be avoided.

Varicose Veins.

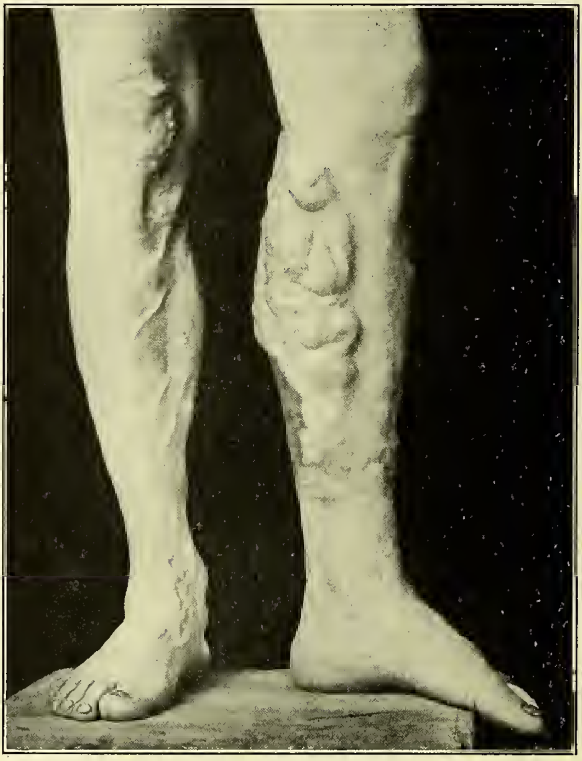
A permanently dilated, lengthened, and thickened condition of the veins occurs in various parts of the body, and constitutes the condition known as varicose veins. The predisposing cause of this pathologic dilatation and enlargement is either increased blood-pressure or diminished resistance of the tissues of the vein, or both combined. The exciting cause is generally some extra muscular strain frequently repeated, or an obstruction in the larger trunks, as from thrombosis, the pressure of tumors, or in the case of the lower extremity, the weight of the pregnant uterus, or the constriction of elastic garters, especially when worn below the knee.

Another, and in the writer's opinion the most important etiologic factor in varicose veins of the leg, is the habit necessitated by certain occupations of constant standing without the opportunity of muscular exercise.

The usual situations in which varicose veins are found are the lower extremities, especially below the knees, the mucous membrane of the anus and lower portion of the rectum (hemorrhoids), and in the tissues of the scrotum (varicocele).

Varicose Veins of the Leg.—A dilated and thickened condition of the subcutaneous veins of the lower leg is of common occurrence, chiefly in middle-aged individuals whose occupations require constant standing. The dilated veins are found, as a rule, to be the tributaries of the internal saphenous vein, which may also partake of the process (Fig. 118). Exceptionally the disease affects the external saphenous and its branches. In the former instance the veins are chiefly on the inner aspect of the calf, while in the latter they are found on the outer side and posteriorly. All three coats of the vein are thickened. The walls are rigid and often calcified. When cut, the vessel remains open like an artery.

FIG. 118.



Varicose veins of leg.

The venous system in the leg consists of two portions, a deep and superficial set of veins. The deep veins collect the blood from the muscles and empty into the anterior and posterior tibials, the peroneal, popliteal, and femoral trunks. The superficial veins form a network of vessels in the subcutaneous tissues, have a number of direct connections with the deep system, and eventually empty into the external or internal saphenous vein, the former joining the popliteal at the back of the knee, the latter the femoral at the saphenous opening. During rest most of the blood from the musculature of the lower extremity passes through the deep veins into the femoral. During violent muscular exertion a large part of the blood from the muscles passes through the unimpeded vessels of the superficial set, which can be seen to dilate during the muscular effort.

The superficial veins, therefore, act as a compensatory system, capable at any time of carrying most, if not all, of the blood returning from the lower extremity. Raymond Russ, who has recently published some interesting studies upon the subject,[1] calls attention to the fact that, while the exact situation of the communicating branches between the deep and superficial systems may vary in different individuals, in general a free anastomosis exists about the dorsum of the foot and ankle, at the knee, and at one or two points between the ankle and the knee where the middle and upper perforating branches are located.

When, for any reason, as congenital weakness or as a result of malnutrition or disease, the walls of a vein become so weakened that it cannot withstand the extra strain of severe and frequently repeated muscular effort, pathologic changes occur. At first a compensatory hypertrophy takes place, which may continue for a time and the functions of the vessel remain intact. At a later period this compensation is broken and permanent dilatation takes place with a resulting incompetency of the valves which, in the case of the main trunk of the internal saphenous, gives an enormous increase in the blood-pressure in its lower branches when the patient is standing, from the weight of the unsupported column of blood.

Trendelenburg long ago called attention to the fact that, as the inferior cava, iliac, and femoral veins have no valves, and that if the valves of the internal saphenous become incompetent, the weight of the column of blood from the right heart to the lower subcutaneous vein of the leg is enormous, and will invariably cause dilatation of the inferior tributaries.

Compensatory hypertrophy of the subcutaneous veins of the leg and thigh is occasionally seen as a result of femoral or iliac thrombosis. In these cases the main trunk of the internal saphenous is more noticeably enlarged than the lower branches, and the superficial epigastric and circumflex iliac partake in the process, often forming large trunks passing from the saphenous opening to the pubis and abdomen.

It is obvious that these vessels should never be disturbed, as the condition is a compensatory anastomosis around the obliterated femoral trunk.

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[1] Surgery, Gynæcology, and Obstetrics, April, 1908.

The question of involvement of the deeper veins of the leg is an important one, and has been investigated by Gay, Quenu, and others. From their investigations it is probable that it occurs in about one-half of the cases. Not infrequently it occurs with but little evidence of disease in the superficial group.

Symptoms.—A moderate degree of varicosity of the superficial veins of the lower leg causes, as a rule, no discomfort. When the valves of the saphenous become incompetent, however, the patient experiences a sense of weight and fulness in the leg and foot, which is promptly relieved on assuming the recumbent posture. In more advanced cases pain is experienced on prolonged standing, and œdema of the lower leg and foot may be present. Thickening, bluish discoloration, and pigmentation of the skin may occur from chronic passive hyperæmia, which also favors the formation of ulcers and eczema. These changes, as a rule, are more marked in the lower half of the leg. This fact serves to distinguish the varicose from the syphilitic ulcer. The latter, while it may occur in any part of the leg, is more frequently observed in the upper segment. Atrophy of the skin over a mass of varicose veins is occasionally present and predisposed to rupture from some slight trauma. The hemorrhage in such cases is often alarming, both from the large size of the vessel and from the fact that the blood flows from both upper and lower segments of the vein.

Where the deeper veins are involved the pain and discomfort are, as a rule, more marked than in the superficial variety. In these cases there is often more œdema on standing. Trendelenburg's sign is frequently absent and the visible dilatations are more marked at the points where the deep anastomosing veins join the superficial system.

Diagnosis.—The diagnosis of varicose veins of the leg often can be made by inspection. When the patient is standing, large tortuous bluish cords can be seen coursing over the calf of the leg and often extending upward along the inner side of the thigh to the region of the saphenous opening. To determine the question of competency of the valves Trendelenburg's test should be applied. The patient is placed upon his back and the leg elevated to allow the veins to become empty. The finger is then firmly placed over the upper portion of the long saphenous vein, just below the saphenous opening, and the patient instructed to stand erect. The lower branches will gradually refill from the deeper veins. If, however, the compression of the saphenous is removed, the blood current generally can be seen to course down the main trunk and rapidly distend the branches. If the fingers are placed over the lower portion of the trunk, the downward rush of the blood imparts to the examining fingers a distinct thrill. In cases of marked obesity, and occasionally in cases of moderate dilatation of the vein, the descending current of blood cannot be seen, but if the valves are incompetent it can always be felt.

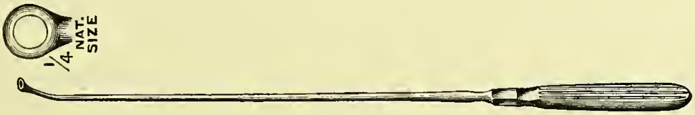
Treatment.—A tendency to varicose veins of the leg sometimes can be arrested in the early stages by wearing an elastic stocking or by the use of a rubber or flannel bandage. Cardiac lesions causing passive venous congestion should be corrected and the wearing of tight garters avoided. Regarding operative treatment considerable care should be exercised in the selection of cases. For instance, it would be manifestly absurd to ligate or remove the dilated superficial veins in a case of femoral or iliac thrombosis. Operation is likewise rarely productive of good in those comparatively rare cases where the chief lesion is located in the deep veins of the leg, the superficial group being dilated only in the region of the anastomosing channels.

Where there is valvular incompetency, however, and evident involvement of the internal saphenous trunk, operation is to be recommended.

A limited removal of the veins is also indicated where they are near the surface and likely to rupture.

Three operative methods are at present employed in this condition: Complete removal of the internal saphenous trunk, either by open excision (Madelung) or by the subcutaneous method (Mayo); multiple excisions of the main trunk and chief branches, and the Trendelenburg operation.

FIG. 119.



Mayo's varicose vein enucleator.

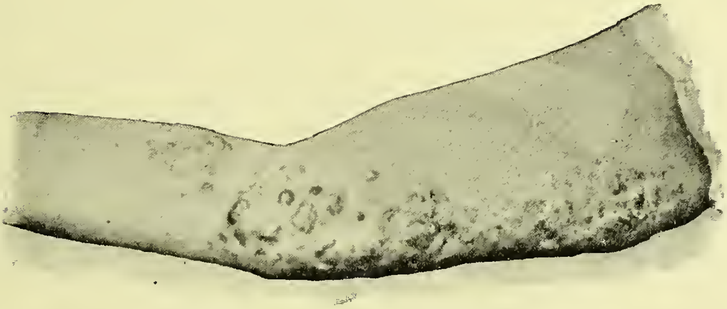
Excision of the main trunk of the saphenous is best accomplished by means of the Mayo ring enucleator (Fig. 119). The upper segment of the vein is exposed by a short incision, the vein double ligated, and divided. The lower portion of the vein is threaded through the ring of the enucleator and held lightly by the left hand of the operator. With the right the enucleator is pushed downward, severing the vein from its branches, until about eight or ten inches are thus freed. The ring is then pressed firmly against the skin and a small button-hole incision made, through which the freed extremity of the vein is drawn. The enucleator is next removed from the original wound and the same procedure repeated through the second incision. In this manner the entire trunk of the saphenous vein often can be removed through three or four insignificant incisions. The torn branches do not, as a rule, bleed much, and the flow is easily controlled by gentle pressure. This method is the ideal one, and in the writer's experience can be carried out in perhaps one-half of the cases which apply for treatment. In the others it is impossible to remove the vein in this manner on account of its friability or the presence of periphlebitis or calcareous deposits. It occasionally happens that the upper portion of the vein can be removed by the enucleator and the lower portion by multiple excisions. One should strive to remove the greatest amount of the pathologic vein through the smallest amount of incision, as long incisions, especially in the œdematous tissues of the lower leg, are very likely to become infected.

In a large number of cases the method by multiple incisions will be indicated. In this an incision should be made over the highest point of the diseased vessel, the vein isolated, double ligated, and a small section removed. Incisions should then be made over the most prominent masses lower down, the vessel excised, the various branches and free extremities of the vein ligated, and the cutaneous wound united. The Trendelenburg method consists in applying an Esmarch bandage to the entire limb, then removing a small section of the internal saphenous vein near the saphenous opening, and keeping the patient in bed until the wound is healed, the theory of its action being that it removes the pressure from the subcutaneous veins of the leg, which gradually regain their tone and diminish in size. This method of treatment is undoubtedly efficacious when the disease is limited to the internal saphenous system, and in the early stages of the malady before the walls of the dilated veins have become permanently thickened. Treatment of varicose veins by injection of coagulating agents into the vein or by acupressure pins is not to be recommended.

Nævus, or Venous Angioma.

This affection consists in a mass of dilated capillaries or veins situated in the skin or subcutaneous tissues. The disease is generally congenital, although it is apt to spread and is sometimes first noticed at a later period of life. When the disease is limited to the capillaries it appears as a small red or blue discoloration of the skin which disappears on pressure and quickly returns when the pressure is removed. Occasionally large areas of the skin are involved, making the so-called "port wine" or "birth marks." If the smaller veins are involved in the process, the disease appears as an elevated, soft, spongy mass of irregular outline, of bluish or purplish tint, compressible, and rendered more prominent if on the face or neck by crying, coughing, or sneezing. When situated wholly in the subcutaneous tissue the discoloration may be slight, only a dusky hue being noticeable on the surface of the mass. In rare instances the disease is associated with an increase in the fatty tissue, making a mixed growth—*nævolipoma.*

FIG. 120.



Congenital venous nævus. (Halloway.)

Treatment.—When possible, complete excision is to be recommended in the larger venous angiomata, with arrest of bleeding and primary closure of the wound. In the smaller nævi the application of the Paquelin cautery point or of red-hot needles will often bring about a cure. Electrolysis has been successful in small angiomata and in port-wine marks of moderate extent. The method of its application is to introduce two insulated needles into the tumor some little distance apart and to apply through them the galvanic current until the tissues become hardened and white. Several applications are often necessary. The resulting scar is insignificant. Subcutaneous cauterization, by means of Blake's platinum-pointed cautery needles, which are thrust into the tumor from opposite sides, and rendered red hot by contact of the points, which completes the electric circuit; or by the subcutaneous injection of boiling water as recommended by Wyeth,—is being largely employed at present with good results. Recently Charles T. Dade has called attention to a new method of treating angiomata which, in the smaller varieties, bids fair to supersede all others. His method consists in freezing the part by direct application of liquid air by means of a blunt cotton swab. In the smaller nævi only one application is necessary; in those of larger extent two or three may be required. The application causes only moderate pain and the resulting scar is thin and pliable. The use of the subcutaneous ligature was formerly much employed in the treatment of cutaneaus angiomata, also the use of pure nitric acid. Both of these methods, however, have been practically abandoned.

LIGATION OF ARTERIES IN CONTINUITY.

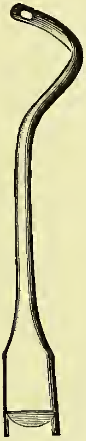
Ligation of arteries in continuity is required for the control of hemorrhage when the bleeding point is inaccessible or the vessels diseased. It is also required to arrest the flow of blood through an aneurism, or as a preliminary procedure in amputations and other major operations when hemorrhage is difficult to control.

The instruments required for this operation are a scalpel, two toothed forceps, two retractors, an aneurism-needle, scissors, artery-clamps, needles, and a needle-holder.

The materials used for ligature are chromicized catgut, chromicized kangaroo-tendon, braided or floss silk.

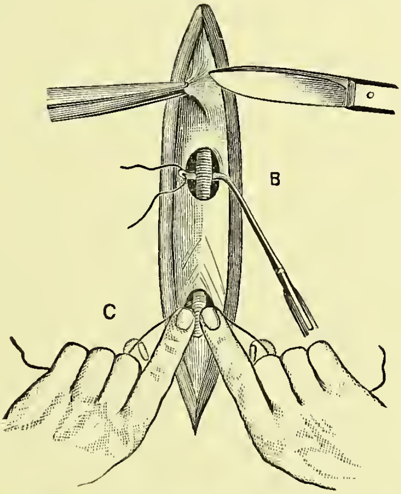
The patient should be placed in such a position as to give the best exposure of the part, the artery should be accurately located by anatomic landmarks, and the tissues divided layer by layer until the vessel is reached. When possible, muscles, nerves, and veins should be retracted rather than divided, and layers of fascia, intermuscular septa, and areolar tissue cut rather than torn. Veins which cannot be retracted should be divided between two ligatures. When the sheath of the artery is freely exposed, it should be grasped and raised in a transverse fold by two toothed forceps, then carefully opened by scissors or the point of the scalpel, the back of which is directed toward the artery. When the sheath is freely open the artery should be separated from it and the aneurism-needle (Fig. 121) passed around the vessel, threaded with the ligature, and carefully withdrawn (Fig. 122). The ligature should then be tied snugly with a reef or surgeon's knot, the former in superficial vessels, the latter when the vessel lies deeply and when accidental slipping of the knot cannot be readily appreciated. It was formerly supposed that the ligature should be tied with sufficient force to rupture the inner coat of the vessel, but the modern view is that equally good results can be obtained by simply drawing the walls together without rupture of any of the coats. The latter method is less likely to be followed by secondary hemorrhage. Some surgeons advise double ligature and dividing the artery between the two knots, for the reason that the arteries are elastic tubes, and are always, under normal conditions, subject to a certain amount of tension, as shown by prompt retraction of their divided ends when cut. This tension favors rupture of the vessel at a point weakened by the application of a ligature. While these reasons are theoretically correct, this accident practically never occurs in aseptic wounds when ordinary care is used in the application of a ligature to a healthy vessel. After the ligature is tied and cut, the wound should be closed in the usual manner and an aseptic dressing applied. When the main arterial trunk of a limb has been ligated, the extremity should be wrapped in cotton-wool and slightly elevated to favor return venous circulation.

FIG. 121.



Aneurism needle.

FIG. 122.



A, opening sheath; *B*, passing ligature around the vessel; *C*, tying the artery.

A good deal has been written in the older text-books about the introduction of the aneurism-needle—that it should always be carried around the artery in a direction away from the most important neighboring structure. The rule is a good one, and should be followed under ordinary circumstances; but many other factors may influence the surgeon at the time of operation. In clean, dry wounds in which the structures are freely exposed, it makes little or no difference in which direction the needle is passed.

It is well to remember that all the arteries of the upper extremity and all below the knee in the lower extremity are accompanied by two veins, known as venæ comites. The arteries of the head and neck, except the lingual, the arteries of the thigh, and most of the arteries supplying the thoracic and abdominal viscera, have a single accompanying vein. Above the diaphragm all important venous trunks which accompany the arteries, when not in the same plane, lie above the arteries; below the diaphragm the veins not lying in the same plane lie below the arteries except the renal.

The **innominate artery** is exposed by an incision along the inner border of the lower third of the sternomastoid muscle, extending one inch below the sternoclavicular articulation. The superficial fascia and platysma are divided, and the anterior jugular vein secured between two ligatures and cut. The deep cervical fascia is split and the attachments of the sternomastoid, sternohyoid, and sternothyroid muscles partly divided, the former drawn outward and the two latter inward by retractors. The sheath of the common carotid is opened and the artery followed downward until the trunk of the innominate is reached. If the bifurcation is low, it will be necessary to resect a portion of the sternum and the sternal extremity of the clavicle, to secure enough space to apply the ligature successfully. The innominate vein lies to the outer side and above the artery. Care should be taken in passing the aneurism needle to avoid the vagus nerve and pleura, which also lie to the outer side of the artery.

The **common carotid artery** is exposed by an incision along the inner border of the sternomastoid muscle on a line extending from the sternoclavicular articulation to a point midway between the angle of the jaw and the tip of the mastoid process. The incision should extend from a point opposite the upper border of the thyroid cartilage to a point just above the sternoclavicular joint, and should divide the skin, superficial fascia, platysma, and deep fascia. A vein passing from the anterior jugular to the temporofascial vein will be divided; also the sternomastoid branch of the superior thyroid artery. The sternomastoid muscle is retracted outward with the internal jugular vein; the anterior belly of the omohyoid muscle crosses the incision about its middle, passing from above obliquely downward and outward. The artery may be tied either above or below this muscle. It is easily recognized by its pulsation, and also by its relation to the carotid tubercle on the transverse process of the sixth cervical vertebra. The artery lies just above this tubercle at the point where it is covered by the omohyoid muscle. By retracting the sternohyoid and sternothyroid muscles inward and the omohyoid upward, the sheath of the vessel will be exposed in the *triangle of necessity;* by retracting the omohyoid downward and inward the upper portion may be reached in the *triangle of election.* As the descendens noni nerve lies on the anterior wall of the sheath, this should be opened on the inner side. If the needle is passed around the artery *within* the sheath, there is no danger of including the vagus, which lies behind it.

The **external carotid artery** is exposed by a continuation upward of this same incision. The artery begins at the bifurcation of the common carotid opposite the upper border of the thyroid cartilage, and ends by division into the internal maxillary and temporal, within the parotid gland. It is crossed by the superior thyroid, lingual, and temporofacial veins, by the hypoglossal nerve and the digastric muscle. It is recognized by its numerous branches. It is easily exposed and ligated just above the origin of the superior thyroid branch at a point opposite the great cornu of the hyoid bone.

The **internal carotid artery** is exposed by the same incision as the external carotid. It lies behind and a little to the outer side of the external carotid and can be brought into view by drawing the external well inward. It has no branches.

The **superior thyroid, lingual, facial, and occipital** may all be exposed and ligated near their origins from the external carotid through this incision. The *lingual* is often ligated after it passes beneath the hyoglossus muscle; by exposing this muscle by retracting the submaxillary gland upward and separating its fibres the artery will be found midway between the hypoglossal nerve and digastric tendon, running inward parallel with the nerve. The *facial* artery may also be exposed and tied as it crosses the lower border of the jaw just in front of the masseter muscle. A short horizontal incision, including the skin, fascia, and platysma, will expose the artery and vein.

The **temporal artery** may be exposed as it crosses the zygoma just in front of the external auditory meatus. It lies beneath the skin and fascia, and is in relation to the auriculotemporal nerve, which should be recognized and avoided in passing the ligature.

The **subclavian artery** can be safely exposed and ligated in its third portion or that part which passes from the outer border of the scalenus anticus muscle to the lower border of the first rib. The patient should lie on his back on the table with a sand-bag under the shoulder; the head should be turned to the opposite side and the arm drawn well downward. A horizontal incision three inches in length should be made over the clavicle, after drawing the skin well downward to avoid the external jugular vein. When the skin is relaxed the incision will appear half an inch or more above the bone. The superficial fascia, platysma, and one or two superficial veins will be divided, also the deep fascia. If the space between the trapezius and sternomastoid muscles is too narrow, these should be partly divided at their attachment to the clavicle and well retracted. The external jugular vein, and occasionally other large branches, should be carefully retracted or divided between two ligatures, the omohyoid muscle located and drawn upward. The artery can be recognized by its pulsation, passing outward from behind the scalenus anticus muscle, lying on the scalenus medius and first rib. The subclavian vein lies in front and below, the brachial plexus above and to the outer side. These structures and the pleura should be avoided in passing the needle.

The **vertebral artery** may be exposed by an incision along the posterior border of the lower half of the sternomastoid muscle. This incision includes the skin, superficial fascia, platysma, and deep fascia. The sternomastoid is retracted inward, the scalenus anticus muscle recognized, and the space between it and the longus colli muscle cleared. The artery lies just below the transverse process of the sixth vertebra. The vein lies anteriorly and should be retracted. The ligature occasionally includes some fibres of the sympathetic, which would be indicated by a subsequent contraction of the pupil.

The **inferior thyroid artery** may be exposed through the incision for ligature of the common carotid in the *triangle of necessity.* After the carotid sheath is exposed, it is retracted outward with the sternomastoid muscle, the sternohyoid and sternothyroid muscles and the thyroid gland are drawn well inward, and on the floor of the space thus formed the inferior thyroid artery will be seen passing inward just below the transverse process of the sixth cervical vertebra. It should be ligated as far outward as possible, to avoid the recurrent laryngeal nerve.

The **axillary artery** may be ligated in its first and third portions. The first part is exposed by an incision, horizontal or slightly curved upward, just below the clavicle from the inner border of the deltoid to a point near the sternoclavicular articulation. The clavicular fibres of the pectoralis major are divided and the tendon of the pectoralis minor exposed. The costocoracoid membrane is next divided and the acromial thoracic artery and the cephalic vein followed downward to their junction with the main trunks. The artery can be recognized by its pulsation and by its position below the cords of the brachial plexus and above the vein.

The third portion of the artery is exposed in the axilla. The arm is held at a right angle with the body and an incision three inches in length is made along the course of the artery, which can be easily located by its pulsations. Division of the skin and fascia will expose the vein, which lies above and to the inner side of the artery. The ulnar and internal cutaneous nerves lie to the inner side below the vein, the musculocutaneous to the outer side, and the median just above the artery. These should be retracted, the venæ comites separated from the artery, and a ligature applied below the origin of the circumflex branches.

The **brachial artery** lies just beneath the skin and fascia along the inner border of the biceps muscle, corresponding with a line drawn from the junction of the anterior and middle thirds of the outlet of the axilla to the middle of the bend of the elbow. The vessel is exposed in the middle of the arm by an incision along the inner border of the biceps muscle, dividing the skin and fascia. The artery is easily recognized by its pulsations. The median nerve lies upon the artery and should be retracted. The sheath is next opened and the ligature placed about the vessel, care being taken to avoid the venæ comites. At the bend of the elbow the artery can be easily exposed by a short oblique incision along the inner side of the biceps tendon parallel with the median basilic vein. The bicipital fascia is divided and the artery with its venæ comites exposed.

The **radial artery** may be exposed at any part of its course in the forearm, or in the *tabatière* between the extensor tendons of the thumb. The line of the artery extends from the middle of the bend of the elbow to a point midway between the tendons of the flexor carpi radialis and the palmaris longus at the wrist. In the middle and upper part of the forearm the artery is reached by an incision along the line of the vessel. After division of the skin and fascia the inner border of the supinator longus muscle is found and retracted outward. This exposes the vessel and its venæ comites. The radial nerve lies to the outer side of the artery. In the lower third of the forearm the artery lies between the tendons of the supinator longus and flexor carpi radialis, and may be easily reached by an incision which exposes these structures. In the tabatière the artery may be exposed by an oblique incision in the triangular space between the extensor tendons of the thumb. A superficial vein is encountered which may be retracted or divided. The artery lies immediately below the deep fascia.

The **ulnar artery** can be exposed at the bifurcation of the brachial by an oblique incision just below the bend of the elbow along the upper border of the pronator radii teres muscle and retracting the muscle inward. The artery is reached by following the brachial downward. In the middle of the forearm the artery lies beneath a line extending from the tip of the internal condyle to the outer side of the pisiform bone. An incision is made along this line dividing the skin and superficial fascia. The white line of the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis digitorum is found and the muscles separated. The artery with the accompanying venæ comites will be found at the bottom of the wound. The ulnar nerve lies to the inner side of the artery. Above the wrist the artery is easily reached by an incision along the same line, just to the outer side of the tendon of the flexor carpi ulnaris. After the deep fascia is incised and the tendon of the ulnar flexor drawn inward, the artery is easily found and ligated. The ulnar nerve lies to the ulnar side of the artery.

The **abdominal aorta** has been ligated on several occasions for hemorrhage or aneurisms of its lower segment or of the iliac arteries. Although no case has up to the present time recovered from the operation, the procedure is still regarded by surgeons as a justifiable experiment in certain cases. The vessel may be reached by two routes, the abdominal and the retroperitoneal or lumbar. The former is to be preferred, not only on account of the ease of its peformance, but also for the reason that the latter is associated with grave danger of sloughing of the colon from accidental injury to the branches of the inferior mesenteric artery. An incision is made just to the left of the median line opposite the point selected for the ligature and the abdominal cavity freely opened. The small intestines are drawn aside and retained by gauze pads. The vessel is recognized by its size and pulsations. The parietal peritoneum is divided and the aneurism needle passed around the artery in such a manner as to avoid injuring the sympathetic plexus which surrounds the vessel. Floss silk or flat kangaroo-tendon should be used for the ligature, and the knot should be drawn with only sufficient force to cause arrest of the flow of blood, and not to injure the vessel-walls. In case of aneurism a temporary ligature is indicated, and is not necessarily drawn sufficiently tight to occlude the lumen of the vessel completely.

The **common iliac artery** may be reached by a transperitoneal incision through the median line or along the outer border of the rectus muscle. The intestines are packed aside and the vessel easily recognized by its pulsation. In dividing the peritoneum over the vessel care should be taken to avoid wounding the ureter, which crosses the vessel near its bifurcation. The iliac vein lies below and to the right of the artery. The Trendelenburg posture is to be recommended in this operation. The operation generally employed to expose this vessel is by the curved inguinal incision of Mott for exposing the iliac vessels. This incision begins one inch above the centre of Poupart's ligament, and is carried upward and outward in a curved direction, keeping about one inch to the inner side of the ligament and the anterior superior spinous process of the ilium, then carried upward and slightly inward toward the umbilicus. The incision is about eight inches in length, and is carried downward through the various muscular layers and transversalis fascia until the subserous fat is reached. The peritoneum is then carefully separated from the iliac muscle and retracted toward the median line until the psoas muscle and iliac vessels are freely exposed. The ureter is generally raised from the vessel with the peritoneum. By retracting the edges of the wound a good view of the common and external iliac vessels can be obtained, and a ligature can be applied at any point.

The **internal iliac artery** is reached best by means of a transperitoneal median incision below the umbilicus, the patient being in the Trendelenburg position. The artery can be recognized by tracing it downward from the common iliac. Care should be taken to avoid wounding the ureter and the accompanying vein.

The **external iliac artery** can be exposed by the transperitoneal operation or by the incision of Cooper, which is practically the same as the lower four inches of the Mott incision described above for the common iliac artery. When the peritoneum is retracted, the artery is seen lying upon the inner border of the psoas muscle. The vein lies to the inner side of the artery, and the anterior crural nerve to the outer side, the genitocrural on the vessel. High up it is crossed by the vas deferens, and occasionally by the ureter. The writer has exposed the artery for temporary compression on several occasions by the intermuscular method, following the McBurney procedure for interval appendectomy until the peritoneum is reached, then stripping it from the iliac muscle as in the Cooper operation. The artery can be exposed by this method throughout its entire extent and can be easily ligated. After ligation the tissues fall together, and it is only necessary to unite the aponeurosis of the external oblique and the skin.

The **gluteal artery** may be exposed by an incision on a line passing from the posterior superior spinous process of the ilium to the great trochanter. The artery emerges from the sciatic notch above the pyriformis muscle opposite the junction of the upper with the middle third of this line. The fibres of the gluteus maximus and medius should be separated and well retracted. The gluteal nerve lies below the artery.

The **sciatic artery** emerges from the pelvis below the pyriformis muscle with the sciatic nerve and internal pudic artery, at a point opposite the junction of the lower and middle thirds of a line drawn from the posterior superior spinous process to the tuberosity of the ischium. It can be exposed by a perpendicular or oblique incision.

The **common femoral artery** is only about one and one-half inches in length. Its position and that of the superficial femoral may be indicated by a line drawn from a point on Poupart's ligament midway between the anterior superior spinous process and the symphysis pubis to the adductor tubercle on the inner condyle of the femur. The incision should be made along the line beginning half an inch above Poupart's ligament and extending three inches below that point. The superficial veins should be retracted or divided, the deep fascia opened, the artery recognized by its pulsations, the sheath incised and the needle passed away from the vein, which lies to the inner side of the artery.

The **superficial femoral artery** in Scarpa's triangle is exposed by a similar incision carried further downward, and ligated in the same manner. The superficial femoral artery in Hunter's canal is exposed by an incision three or four inches in length along the line of the artery in the middle third of the thigh. The deep fascia is incised and the sartorius muscle recognized and retracted inward. The roof of the aponeurotic canal is exposed by this retraction and is opened on a director. The artery is easily felt and separated from the vein, which lies behind and to the outer side of it. The long saphenous nerve crosses the artery from without inward.

The **popliteal artery** may be exposed by an incision along a line drawn from a point just inside the inner hamstring above, to the middle of the lower part of the popliteal space below. The skin, superficial, and deep fasciæ are divided, and the artery recognized by its pulsations. If ligation is to be performed in the upper part of the space, the nerve and vein will be found to the outer side of the artery, and should be drawn outward. If the lower portion of the artery is to be ligated, the nerve and vein will be found to the inner side of the artery, and should be retracted inward. In this operation the external saphenous vein, the external saphenous nerve, the plantaris muscle, and the sural arteries will be exposed and must be avoided.

The **anterior tibial artery** may be exposed in any part of its course by an incision along a line drawn from a point midway between the head of the fibula and tuberosity of the tibia to a point opposite the middle of the front of the ankle. The incision should divide the skin, superficial fascia, and deep fascia. The line of division between the tibialis anticus and extensor proprius pollicis should be recognized and the two muscles separated and held well apart. The artery will be found at the bottom of the space thus formed, lying on the interosseous membrane. The nerve lies to the outer side of the artery. In the upper third of the leg the white line between the two muscles may not be distinctly seen. In this case a small arterial branch may sometimes be found between the two muscles, which will serve as a guide. The intermuscular septum lies from three-quarters to one inch from the crest of the tibia.

The **posterior tibial artery** follows a line drawn from the middle of the lower part of the popliteal space to a point midway between the tendo Achillis and the internal malleolus. It can be ligated in the middle of the leg through an incision a finger's breadth behind the inner border of the tibia. This should expose the long saphenous vein and nerve, which should be retracted. The deep fascia is next split and the edge of the gastrocnemius muscle drawn aside. The tibial attachment of the soleus is recognized and divided at a point half an inch from the bone. Beneath this the vessels and nerve will be found enclosed in a process of the deep fascia lying on the flexor longus digitorum muscle. The nerve lies to the outer side of the artery. The artery is exposed at the ankle by a semilunar incision midway between the tendo Achillis and the internal malleolus, following the curve of the latter. The artery is superficial in this position, and lies just beneath the deep fascia. The nerve is external to the vessel. Care should be taken to avoid opening the tendon-sheaths.

The **peroneal artery** may be exposed by an incision along the posterior border of the fibula, dividing the skin and fascia, retracting the gastrocnemius muscle, and incising the tibial attachment of the soleus. The artery lies near the fibula just beneath the deep fascia.

The **dorsalis pedis artery** is exposed by an incision along a line drawn from the centre of the front of the ankle to the upper part of the first interosseous space. The vessel lies between the tendons of the extensor proprius pollicis and extensor longus digitorum, and sometimes is covered by the extensor brevis digitorum.

CHAPTER XI.

INJURIES AND DISEASES OF THE LYMPHATIC SYSTEM.

INJURIES OF THE LYMPH-CHANNELS.

As lymphatics are present in every organ and tissue of the body, every wound, cut, or severe contusion must necessarily be associated with injury to some lymphatic structure. Unless the injury involves the largest and most important lymph-vessels, however, little or no disturbance results, and no special treatment is required. Injuries of the thoracic duct or its larger mesenteric branches (lacteals) may result from severe traumata, as fractures of the spine, severe crushes or contusions of the thorax and abdomen. These injuries are not infrequently fatal from failure of a large amount of the nutritive products of digestion to reach the blood. In such cases the chyle collects in the abdomen, pleura, or in the retroperitoneal or retropleural connective tissue, forming *chylous ascites*, *chylothorax*, or large retroperitoneal collections of chylous fluid, which may become infected, burrow, and point in the groin or in other remote situations. Accidental injuries of the thoracic duct at or near its terminal delta in the neck have occasionally occurred as the result of surgical procedures. The pathognomonic symptom of this injury is the sudden flooding of the wound with a milky fluid, which issues from the region of the junction of the deep jugular and subclavian veins.

The **treatment** of chylous ascites or chylothorax has up to the present time been simply the employment of means to remove the fluid from these cavities to overcome the untoward effects of pressure. In several instances this has eventually been followed by a cure. Laparotomy with a view to locating and securing the leaking vessel would be indicated in a case of chylous ascites which persisted after one or more tappings. In accidental wounds of the cervical portion of the thoracic duct the leaking point should accurately be located, clamped and ligated, and the wound closed in the usual manner. In the majority of instances in which this plan has been carried out no untoward results have followed, probably for the reason that only one of the several terminal branches of the duct was injured; or, if the main duct was ligated, the anastomosing channels which are usually present between the duct and the upper two or three intercostal veins subsequently dilated and carried on the circulation.

DISEASES OF THE LYMPH-CHANNELS AND LYMPH-NODES.

Lymphangitis; Lymphadenitis.

A certain amount of lymphangitis is present in the neighborhood of all infected wounds, and cellulitis, and has been described in Chapter IX. As the function of the lymph-nodes is to arrest infectious matter carried upward through the lymph-channels toward the blood, and to hold this poisonous material until the local process has subsided or until the blood is capable of neutralizing or eliminating it, the nodes become enlarged, tender, and often acutely inflamed during the progress of a septic inflammation in the region drained by their afferent channels. Certain forms of infection have apparently little tendency to cause inflammation in the lymphatic vessels or nodes; while others, as those due to the streptococcus group of micro-organisms, attack at once the lymphatic structures, spread rapidly along the channels, and cause early enlargement of the nodes.

The **symptoms** of lymphangitis are pain, tenderness, and the presence of lines or patches of redness and œdema extending upward along the chief lymph-vessels toward the trunk. The lymph-nodes along the course of these vessels enlarge, become tender to the touch, and may be surrounded by an area of redness and œdema of the skin and cellular tissue. With these local symptoms there is generally considerable systemic reaction, evidenced by chills, fever, headache, general malaise, and more or less prostration. In the milder cases these symptoms rapidly subside as soon as the original source of the infection is removed and secondarily infected areas are opened and drained. In the severer cases, when the original infection is a virulent one, as an autopsy or other poisoned wound of the finger, the general symptoms may precede by several hours the local manifestations, and a high grade of septic intoxication or even true septicæmia may develop. Extensive and often multiple areas of suppuration follow lymphangitis, due to perivascular cellulitis or glandular abscess.

The **treatment** of lymphangitis in the early stages should consist in removal, if possible, of the original focus of infection, and the application of a dressing of mercuric chloride (1 : 5000) or of aluminium acetate to the inflamed areas. This is often promptly successful. If, however, there is a marked tendency of the process to extend, and if the general symptoms are progressive, free incisions through all infected areas should be made and wet antiseptic dressings applied. In this way extensive and deep-seated areas of suppuration can often be avoided, and systemic absorption is thereby limited. In the virulent cases, when the lymph-nodes are acutely inflamed, and especially when they are surrounded by an area of advancing cellulitis, and evidently forming new foci of infection, they should be thoroughly removed. In milder cases they should not be disturbed, as their function is undoubtedly protective.

The abscesses resulting from an acute lymphangitis should be opened and drained. In the early stage of an acute lymphangitis, as in other forms of cellulitis, the employment of Bier's hyperæmic treatment is to be recommended.

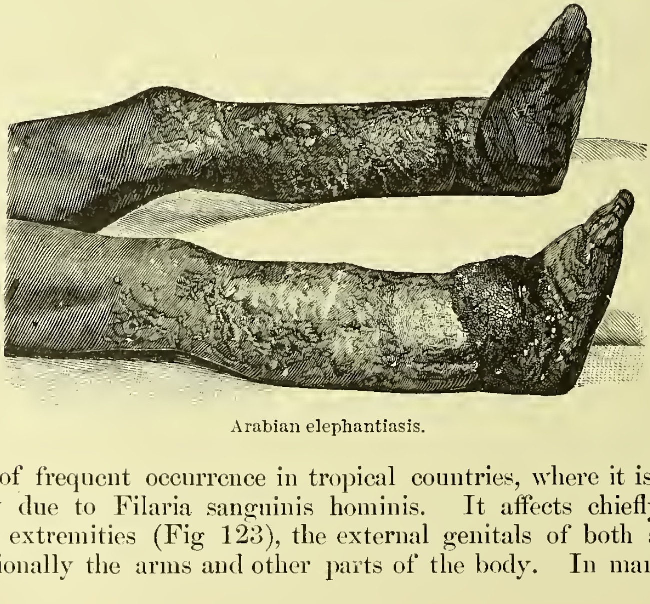
Obstruction of the Lymph-channels.

Obstruction of the lymph-channels may be due to inflammatory processes, to the pressure of new growths, to the presence in the lymph-channels of a parasite, *Filaria sanguinis hominis,* or to congenital conditions the nature of which is not understood. Obstruction of the lymph-channels may result in *lymphœdema,* or swelling of all the lymph-channels and spaces over a large area, or to localized swellings or vascular dilatations.

Lymphœdema, or Elephantiasis.

Lymphœdema, or elephantiasis, is a condition of hypertrophy of the skin and cellular tissue resulting in frightful deformities.

Fig. 123.

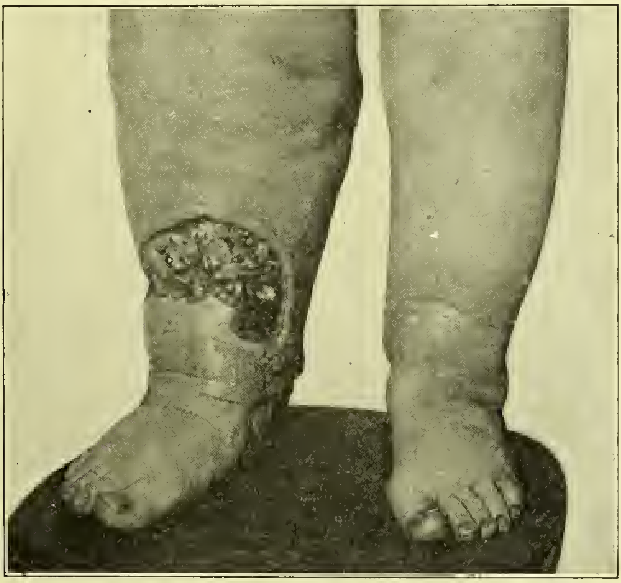


Arabian elephantiasis.

It is of frequent occurrence in tropical countries, where it is generally due to Filaria sanguinis hominis. It affects chiefly the lower extremities (Fig 123), the external genitals of both sexes, occasionally the arms and other parts of the body. In many instances elephantiasis of filarial origin is observed without the presence of embryos in the blood. In these cases it is probable that the parent worms occupy the main lymphatic channels of the affected limb, and by their presence cause an obliterative inflammation which prevents their embryos gaining entrance to the general lymph or blood streams.

The chief pathologic factors in elephantiasis are, first, an obstructed lymph-current, and second, an enormous overgrowth of connective tissue. The skin becomes exceedingly thick, coarse, pigmented, and thrown into folds and creases. There are often a foul discharge and tendency toward the formation of ulcers. The same condition is not infrequently seen in the foot and lower leg of an individual suffering from chronic ulcer when the ulcer is extensive and nearly encircles the limb (Fig. 124). Gerrish has reported an example of elephantiasis of the scrotum due to the pressure of a double truss worn for the relief of hernia.

FIG. 124.



Old ulcer of the leg with lymphœdema.

Symptoms.—The symptoms of elephantiasis are at first only an œdema and moderate enlargement of the limb. Later there occur attacks of dermatitis, or erysipelas with fever, lumbar pain, and general malaise. This causes a thickening of the skin which, as the subcutaneous areolar tissue hypertrophies, forms creases and folds in which dirt, sebaceous material, and moisture collect, giving rise to a foul-smelling and irritating discharge. In many instances the increase in size of the affected part is enormous, and constitutes a disfiguring and burdensome deformity. These extreme examples of the disease are rarely seen in temperate climates, but in some tropical countries where filariasis is common a fair proportion of the inhabitants suffer from the malady.

Treatment.—The treatment of this condition is unsatisfactory. In some instances, in the early stage of the affection, elevation of the limb, massage, and bandaging may be of temporary benefit. As a rule, however, surgical advice is not sought until the disease is well advanced. Warm baths and care in the cleansing of the cutaneous creases and pockets is essential for the prevention of infection. Operative treatment is to be recommended when the disease becomes burdensome. In a number of cases of elephantiasis of the lower limb, much can be accomplished by removal of large wedge-shaped areas with subsequent closure of the wounds and aseptic healing. In this manner limbs can sometimes be rendered useful, which before operation were a serious impediment to locomotion. The employment of multiple setons for lymphœdema has recently been suggested, and considerable improvement has followed their use, especially in the swollen arms which not infrequently follow a complete breast amputation. In some instances amputation is to be recommended. If the disease affects the scrotum or labia majora, complete or partial ablation is to be advised.

In all operative procedures upon these cases great care should be exercised in regard to hæmostasis, as the vessels, particularly the veins, are enormously enlarged and hemorrhage is often alarming.

Localized Lymphatic Dilatations; Lymphangiomata.

In this condition the dilated lymph-vessels resemble the angiomata of bloodvessels, except that the mass is colorless. The disease may affect the lymphatic capillaries or the larger vessels, giving rise in the former instance to small areas of colorless dilated lymphatics, the so-called *lymphatic nævi;* in the latter either to cavernous *lymphangiomata*, irregular compressible tumors made up of masses of dilated lymph-vessels; or to the cystic form caused by a greatly dilated single vessel, or a coalescence of several dilated vessels, the *cystic hygroma*, occurring frequently in the neck, and often spoken of as hydrocele of the neck. The etiology of these conditions is obscure; a certain number of the cases of lymphangiomata which occur in the scrotum, groin, and in the retroperitoneal lumbar region are undoubtedly due to Filaria sanguinis hominis. These are often associated with lumbar pain, severe intermittent fever, chyluria, hæmaturia, and occasionally chylous hydrocele. *Macroglossia*, *macrocheilia*, and *macrodactylia*, or enlargements of the tongue, lips, or fingers, are occasionally encountered as congenital affections due to lymphatic obstruction.

The **treatment** of all these conditions is rather unsatisfactory. Electrolysis is to be advised in the smaller lymphangiomata. In the larger cystic hygromata excision is to be attempted. If unsuccessful in this, partial removal with packing will often bring about a cure. Deforming masses in other situations may be removed and the deformities thus created repaired by plastic procedures. As in the case of hæmangiomata, small lymphangiomata can be successfully treated by liquid air.

Tuberculosis of the Lymph-nodes.

Tuberculosis of the lymph-nodes is of frequent occurrence. As in cases of septic infection, the nodes act as barriers and temporarily arrest the transit of infectious material toward the general circulation. Where the primary focus of absorption is small and the resistance of the individual great, the nodes may enlarge, remain stationary for a period, until the original source of infection is removed or disappears, and then gradually disappear, the infectious material which they contain being destroyed by the bactericidal elements of the economy. When the conditions are less favorable to spontaneous resolution, the disease gradually results in destruction of the nodes, the development of periadenitis, with involvement of the surrounding areolar tissue, fascia, and muscle. In the early stages of the affection there is apparently a simple hypertrophy of the nodes, which on cut section present only a pinkish or gray homogeneous appearance. Later, cheesy foci develop and the entire node may caseate and liquefy, or, as a result of secondary infection, an abscess may develop and discharge spontaneously, leaving a chronic fistulous tract leading to a necrotic and partly disorganized lymph-node. The disease occurs most frequently in the cervical region, the source of infection being located in the oral, pharyngeal, or nasal cavity. It also occurs in the bronchial or mediastinal nodes from some tuberculous focus in the lung; in the mesenteric lymphatics, from some focus in the intestine; in the nodes of the groin, axilla, or lumbar region, from foci in the tissues drained by their afferent vessels.

Tuberculosis of the Cervical Lymph-nodes.—This condition is of common occurrence, and gives rise to an ugly deformity, for the relief of which the surgeon is frequently consulted. In the majority of instances the disease arises from some focus in the pharyngeal or faucial tonsil. Less frequently the source of infection is a carious tooth, a suppurating middle ear, or some other open lesion of the nose, mouth, or scalp. It has also been demonstrated experimentally that a tuberculous infection of a cervical lymph-node may follow the application of tubercle bacilli to the nasal mucous membrane without giving rise to a local lesion (Cornet).

A glance at Plate V. will show the general arrangement of the lymph-nodes of the neck. Of the five superficial groups, the occipital group receives the lymph from the back of the neck and posterior portion of the scalp; the mastoid group and those lying on the external surface of the upper third of the sternomastoid muscle, from the parietal region of the scalp and posterior part of the meatus and external ear; the parotid group, from the anterior part of the auricle, the temporal region, and upper part of the face; the submaxillary, from the lateral aspect of the lips, gums, teeth, anterior half of the tongue, and floor of the mouth; the submental, from the same regions, but nearer the median line. The deep cervical group of lymph-nodes which lies beneath the sternomastoid muscle along the internal jugular vein receives the lymph from all of the superficial groups, and extends downward to the junction of the jugular and subclavian veins. It also receives direct channels from the tongue, palate, pharynx, nasal fossæ, and larynx. A knowledge of these facts will often enable one to find the original source of infection when dealing with malignant, septic, or tuberculous involvement of the cervical nodes.

The **symptoms** of this condition are, at first, a painless enlargement of one or more lymph-nodes, which present no evidences of acute inflammation. They feel firm, are discrete, and freely movable. Later, they become larger and adhere to each other and to the surrounding structures, giving rise to irregularly shaped tumors which are more or less fixed. Fluctuation may develop or, if secondary infection occurs, the surrounding skin becomes red and infiltrated. There is at first no apparent effect on the general health, but later cachexia may develop, and fever, night-sweats, and wasting may occur in the later stages. In other cases the disease seems to follow an acute septic involvement of the nodes, as after scarlet fever, acute tonsillitis, or diphtheria. In these instances it is probable that the nodes were already infected by the tubercle bacilli, and that the process was stimulated by the septic invasion.

As a rule, the first nodes to become enlarged are those in the submaxillary region or those situated about the upper third of the internal jugular vein. As the disease progresses the nodes lower down in the chain become involved, also those situated behind the

PLATE V

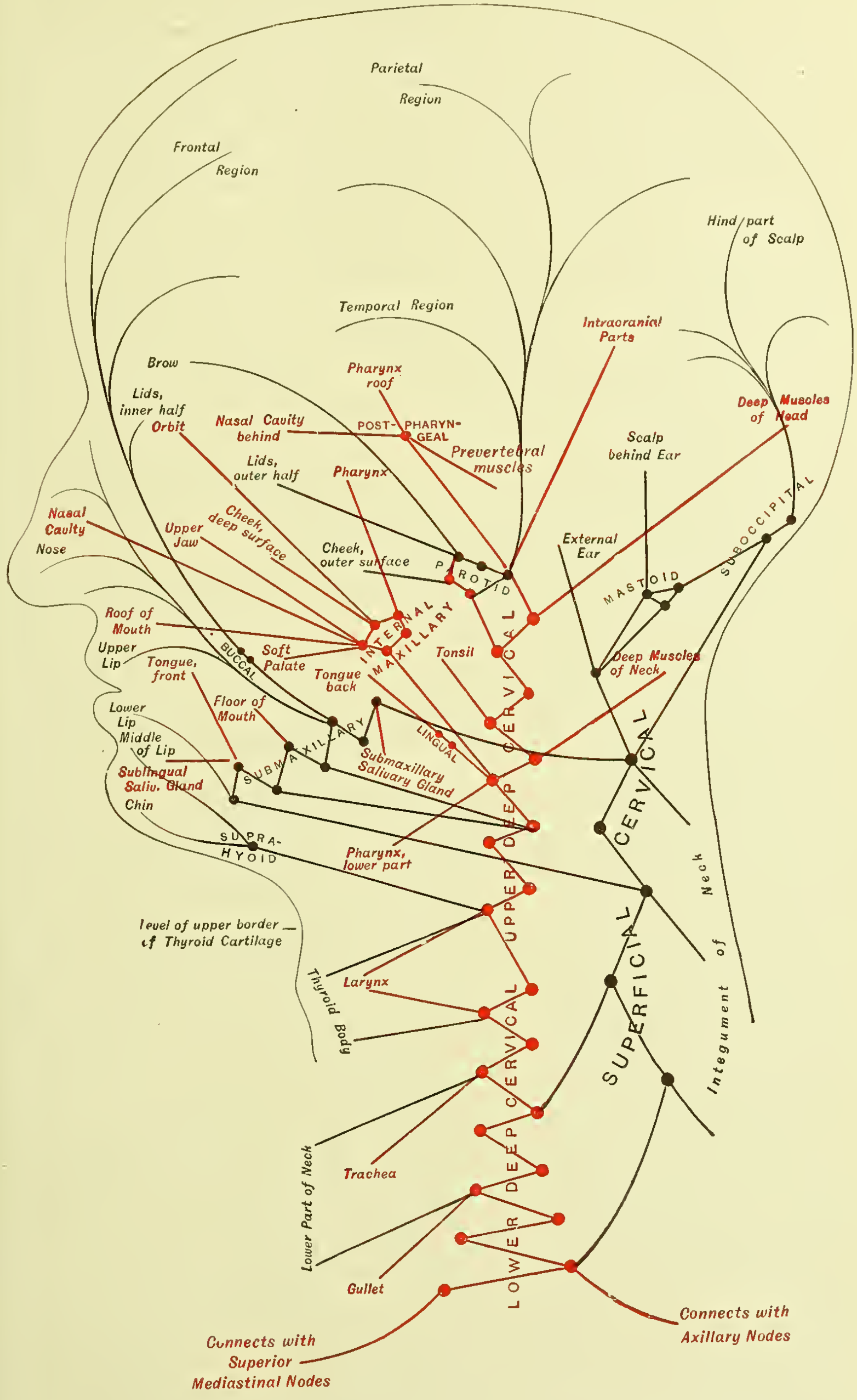
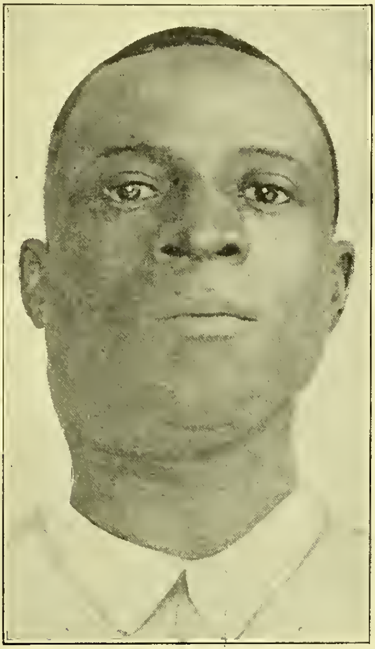


Diagram of the Nodes and Vessels of the Head and Neck, showing the regions that are drained into each group of nodes. (Gerrish.)

Deep structures in red, superficial in black.

sternomastoid muscle, and in the posterior cervical triangle. In advanced cases the entire lateral aspect of the neck may present an irregular nodular enlargement (Figs. 125, 126, 127). When suppuration occurs, which is generally the result of a mixed infection, the skin becomes red and œdematous, fluctuation develops, and spontaneous rupture may occur. The resulting sinus may remain open for an indefinite period, and its external opening is often surrounded by a pouting purple area of infiltration (scrofuloderma).

Fig. 125.



Tuberculous lymph-nodes of neck.

Prognosis.—In a certain number of cases spontaneous recovery follows a change to more favorable hygienic surroundings. Arrest of the process, but with little tendency to resolution, is more frequently observed. In a number of late reports, made by careful observers in cases treated medically, it has been shown that from 20 or 40 per cent. eventually develop tuberculosis of the lungs or other important organs. The results following incomplete surgical operations show little to encourage the timid operator, but in those clinics where thorough and painstaking surgical procedures are carried out, the percentage of recoveries is from 75 to 90.[1]

Treatment.—In the treatment of this disease, as in other tuberculous conditions, certain hygienic measures should always be adopted if the best results are to be obtained. Life in the open air—particularly at the seashore—sleeping out of doors, or in rooms with wide-open windows, and an abundance of good nourishing food will not infrequently result in a spontaneous disappearance of the enlarged nodes without other treatment.

Two methods of surgical treatment are at present employed. The first consists in waiting until the nodes suppurate, and then opening and draining the abscesses; the second is that by the radical removal of all visible tuberculous tissue. In the early stage of the disease, where the tuberculous process is limited to a few nodes which are discrete and movable, the radical operation is a comparatively simple one. At a later period, when the disease has advanced to such an extent that the other tissues are involved, and where suppuration has already occurred, the operation is often

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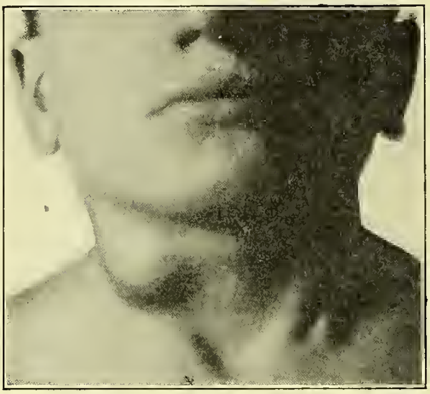
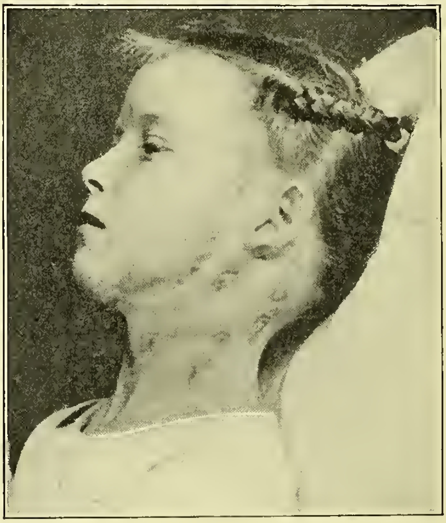
[1] Dowd, "Annals of Surgery," July, 1905.

Fig. 126.



Solitary lymph-node of neck.

Fig. 127.

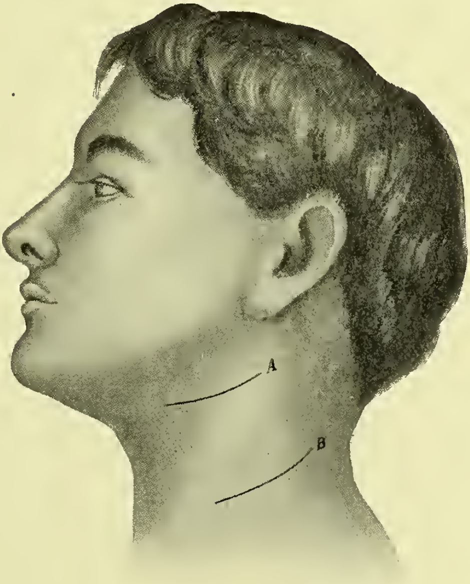


Multiple tuberculous lymph-nodes of neck and face.

one of the most difficult in the field of neck surgery. The latter method, however, is to be recommended whenever the patient is in condition to bear the anæsthetic.

In planning an operation for the removal of cervical nodes, one should select an incision which will give the best exposure of the disease with least scar disfigurement. Longitudinal incisions along the anterior or posterior border of the sternomastoid muscle undoubtedly give the best exposure in most cases, but, unfortunately, they also give rise to broad, unsightly scars. When the disease is located in or near the submaxillary region, a transverse curved incision along the natural cutaneous fold should be employed. In more extensive disease Dowd recommends a second transverse incision lower down (Fig. 128) with or without a vertical extension of the second well behind the sternomastoid muscle. A combination of the upper submaxillary incision with a posterior vertical incision has been frequently employed by the writer in cases of extensive disease (Fig. 129). The horizontal portion of the scar is rarely seen, and the vertical portion, although noticeable from the side, is with difficulty seen from in front.

FIG. 128.

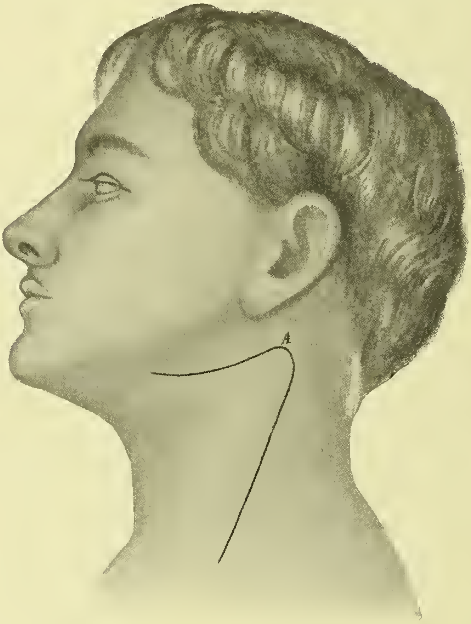


Two transverse incisions for removing moderately enlarged nodes. (Dowd.)

Two important nerves are frequently injured in the large operations, the lower facial branch in the seventh and the spinal accessory. It should be remembered that the former lies one finger's breadth beneath the posterior third of the horizontal ramus of the jaw between the platysma muscle and the deep fascia, covering the submaxillary gland, and that the latter emerges from the posterior border of the sternomastoid muscle three inches below the tip of the mastoid process.

When possible, the individual nodes should be enucleated, largely by blunt dissection. When extensive fascial or muscular tuberculosis exists, a most painstaking and careful dissection will be necessary.

Fig. 129.



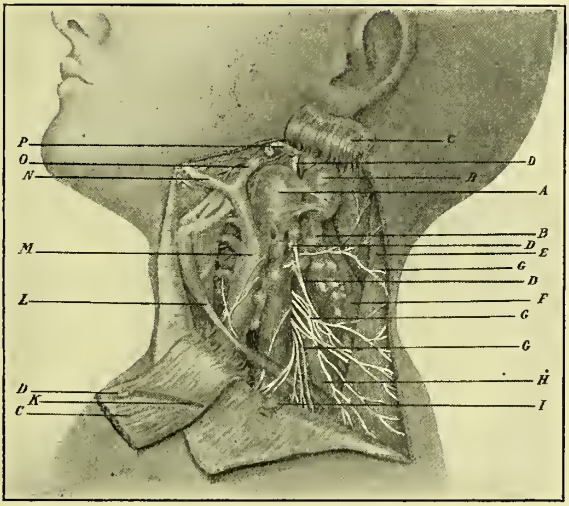
The hockey-stitch incision. (Dowd.)

It frequently happens that portions of the large venous trunks have to be excised, and occasionally a transverse division of the sternomastoid muscle will be necessary. The generous use of a 2 per cent. solution of formalin to disinfect tissues which have become contaminated by rupture of a suppurating gland, followed by irrigation with normal salt solution, often will allow closure of the wound, which would otherwise require packing

Syphilis of the Lymph-nodes.

Enlargement of the lymph-nodes occurs during the early stages of syphilis, and requires no treatment other than the internal use of mercury. *Gummatous infiltration* of the lymphatics, however, may occur late in the disease, and the enlargements thus produced may break down and result in sinuses resembling those caused by tuberculosis, or in extensive syphilitic ulceration of the surrounding skin. As a rule, all of these conditions can be cured by judicious treatment with mercury, potassium iodide, and the local use of blue ointment. Occasionally it will be advisable to remove such gummatous tumors which seem about to break down.

Fig. 130.



Early tubercular infection of the deep cervical chain: *A*, Most prominent caseous node; *BB*, caseous nodes under sternomastoid muscle; *CC*, sternomastoid muscle; *DDDD*, spinal accessory nerve; *E*, trapezius muscle; *F*, levator anguli scapulæ muscle; *GGG*, branches of cervical plexus; *H*, scalenus posticus muscle; *I*, external jugular vein; *K*, course of posterior branch of spinal accessory nerve cut from sternomastoid muscle; *L*, omohyoid muscle; *M*, internal jugular vein; *N*, facial vein; *O*, posterior facial vein (anterior division of temporomaxillary); *P*, parotid gland. (Dowd.)

Chronic Lymphadenitis, Simple Hyperplasia of the Lymph-nodes, or Benign Lymphadenoma.

These are terms which have been applied to chronic non-suppurative enlargements, which are apparently not due to tuberculosis, syphilis, or Hodgkin's disease. Such nodes are occasionally associated with chronic otitis media, facial eczema, pediculosis of the scalp, and other sources of irritation or subacute inflammations in the regions drained by their afferent vessels. If such enlargements do not subside after removal of the peripheral irritation, they are in all probability tuberculous in character or due to Hodgkin's disease.

Malignant Lymphadenoma, or Hodgkin's Disease.

This disease is characterized by a gradual enlargement of the lymph-nodes of the body eventually resulting in grave anemia, progressive asthenia, wasting cachexia, and death. The disease begins by a painless enlargement of several lymph-nodes, generally on one side of the neck. The glands are discrete, freely movable at first, and show no tendency to suppurate or undergo caseous degeneration. The disease gradually extends and involves the glands on the opposite side, those in the axillæ, groins, abdomen, and mediastinum. Later they become fused, forming often enormous irregular masses which cause great disfigurement (Fig. 131). The spleen and other lymphoid tissues enlarge, anæmia and a progressive emaciation occur, and the patients finally die of exhaustion. During the past five or six years considerable discussion has taken place regarding the nature of this disease. The two opinions most commonly held by pathologists are, on the one hand, that it is of tuberculous origin, and, on the other, that it is a form of sarcoma. The evidence which has been submitted on both sides has convinced the partisans of each theory of the correctness of their views, but as yet the question is not authoritatively settled.

The disease is one that belongs rather to the domain of internal medicine than to surgery, as operative treatment in the early stages has accomplished little except the removal of deformity and the relief of pressure-symptoms. It is of surgical interest mainly from the point of view of diagnosis, as it at times closely simulates tuberculous adenitis, and at other times is occasionally mistaken for true lymphosarcoma.

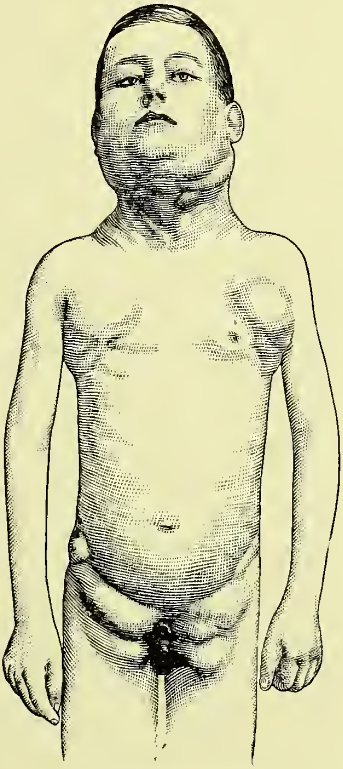
The term *chronic relapsing fever* has been used by Ebstein and others to describe a peculiar symptom complex which is occasionally observed in these cases.

The symptoms of this condition are the occurrence of attacks of high fever and prostration associated with an enlarged and tender spleen and with moderate swelling and sensitiveness of one or more lymph-glands of the neck or in other external regions of the body. The attacks occur at intervals of a few weeks or months, gradually becoming more severe, and finally resulting in profound asthenia, wasting, and death. There are no characteristic blood changes in the early attacks, and the condition often resembles a profound septic intoxication.

Treatment.—The treatment of Hodgkin's disease is unsatisfactory. The *x*-rays will often cause the enlarged nodes to diminish in size for a longer or shorter period.

Arsenic in the early stages will often appear to arrest the process temporarily, but progress is inevitable and death always results. Removal of individual glands is of no avail, and is to be recommended only to relieve pressure-symptoms or to overcome deformity.

FIG. 131.



Hodgkin's disease.

Lymphatic Leukæmia.

Lymphatic leukæmia is an exhausting and fatal general disease, characterized by profound anæmia, an enormous increase in the white corpuscles of the blood, particularly the lymphocytes, and, at a later period, by enlargement of the lymph-nodes of the body. It is to be distinguished from Hodgkin's disease by the fact that in the latter the glandular enlargement appears first and the general symptoms later, and also by the fact that in Hodgkin's disease there is no true leukæmia. While the disease is invariably fatal in the end, the judicious use of the x-rays will often bring about a subsidence of all symptoms, and an apparent return to health for a period of two or more years.

Lymphosarcoma.

Lymphosarcoma occurs as a primary or a secondary affection. Primary lymphosarcoma is a round-cell sarcoma occurring in lymphoid tissue and retaining its lymphatic structure. It occurs in the lymph-nodes, in the tonsil, in the lymphoid tissues of the intestines and other organs. It is one of the most malignant varieties of sarcoma. It begins usually as a simple enlargement of a lymph-node or of other lymphoid tissue, which grows rapidly and painlessly at first. Later the growth infiltrates surrounding tissues, painful pressure-symptoms are produced and metastases occur. Death often results from pressure on important organs before cachexia has had time to develop. The prognosis is grave. Excepting in the very earliest stages treatment is of no avail. Early and thorough removal is, however, to be recommended as the only chance of saving life.

Secondary Sarcoma and Carcinoma.

Secondary sarcoma and carcinoma of the lymphatics are of frequent occurrence, especially the latter. The nature of these processes has been described, and will not be repeated here. Early and complete removal may occasionally arrest the progress of the growth.

CHAPTER XII.

INJURIES AND DISEASES OF THE MUSCLES, TENDONS, FASCIÆ, AND BURSÆ.

Contusions.

THE muscles are often severely contused, lacerated, and the seat of more or less extensive extravasations of blood, as a result of falls, blows, or other varieties of trauma which do not break the skin. In these cases there are localized pain and soreness of the parts, which are increased by motion. Considerable swelling may develop, with fluctuation if the extravasated blood is localized. The treatment should consist in rest and the application of hot laudanum fomentations, aluminium acetate, or lead-and-opium wash.

Rupture of a Muscle or Tendon.

Rupture of a muscle or tendon may occur as a result of some severe unexpected strain upon it. The point of rupture is often at the junction of the muscular with the tendinous fibres, although it not infrequently occurs through the fleshy portion of the muscle or at the bony insertion of the tendon. The rupture may be complete or incomplete, and when it involves the fleshy portion considerable extravasation may be present. Of the more important injuries of this kind, rupture of the quadriceps extensor femoris or its tendon is the one most frequently observed. Rupture of the long head of the biceps, of the tendo Achillis, of the adductor longus, or the tendon of the plantaris, are perhaps next in point of frequency.

The **diagnosis** is made by the occurrence of sudden acute pain during a severe muscular strain, occasionally accompanied by an audible snap. This is followed by a cessation of function in the muscle, efforts to move the part resulting only in a soft swelling over the belly of the muscle, without causing motion of the part to which it was attached. There is tenderness over the point of rupture, and not infrequently a fluctuating swelling due to the extravasation of blood. In ruptures of the tendon of the quadriceps extensor the cavity of the knee-joint may be distended, there is inability to extend the leg, and a depression just above the patella can be felt when the muscle is contracted.

A common form of muscular injury is the so-called *rupture of* *the tendon of the plantaris*, which frequently occurs in tennis players and those who practice jumping. The lesion is in all probability a rupture of a few fibres of the gastrocnemius, and is characterized by the occurrence of a sharp pain in the calf, temporary spasm of the muscle, and later the development of ecchymosis about the ankle.

The **treatment** of these conditions depends upon the degree of functional impairment and the location of the injury. In small ruptures of the fleshy portion of a muscle unaccompanied by serious impairment of function, absolute rest of the part, combined with hot or cold applications, will be all that is necessary. If large muscles are completely torn across or if the resulting disability is great, as in ruptures of the quadriceps or the tendo Achillis, the parts should be freely exposed by incision and the divided ends accurately sutured with chromicized catgut, after which the wound should be closed and the part immobilized by a splint or plaster dressing. Operations of this kind, however, should only be undertaken under conditions in which the strictest aseptic technic can be carried out, especially if the procedure involves opening one of the larger joints. In the small ruptures of the calf muscles, rest and strapping the part with adhesive plaster constitutes the best treatment.

Hernia of Muscle.

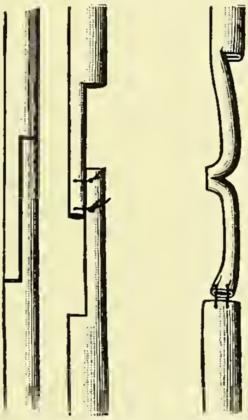
When as a result of trauma the fibrous sheath of a muscle is ruptured, a protrusion of a portion of the belly of the muscle will take place when the muscle is contracted. This forms a hard tumor, which disappears when the part is relaxed. The condition must not be confounded with an extensive transverse rupture of a muscle, which sometimes gives a similar appearance by contraction of its upper fragment. In the latter condition, or *false muscular hernia*, the mass never wholly disappears, moves upward with the muscular contraction, and is always soft.

Treatment.—The treatment of muscular hernia is by operation. The site of the fascial rupture should be exposed and the rent united by catgut sutures, after which the cutaneous wound should be closed, an aseptic dressing applied, and the part kept at rest on a splint.

Wounds of the Muscles and Tendons.

An accidental wound of a muscle or tendon is always an infected wound, and should be disinfected by vigorous scrubbing and shaving the surrounding skin, enlarging the cutaneous wound sufficiently to allow easy access to the remotest recesses of the injured part, and then thoroughly douching with hydrogen peroxide or a 2 per cent. solution of formalin, mercuric chloride, or carbolic acid, followed by irrigation with sterile salt solution. Transverse wounds of muscle should be united with catgut sutures ; longitudinal wounds may simply be allowed to fall together, the fascial layers should be partly united over the muscle and the cutaneous wound closed. In all deep muscular wounds drainage should be provided for by the use of rubber tubes, gauze packing, or small drains of folded rubber protective tissue. In wounds of the tendons search should be made for the divided ends, which often retract for a considerable distance within their sheaths. When found, these should be drawn together by a retention suture passed through the centre of the tendon at a distance of a quarter of an inch or more from the divided ends, and the edges carefully adjusted by two or more fine sutures of chromicized catgut or silk. If the two ends of a divided tendon cannot be approximated, the position of the limb should be so changed as to bring about the greatest degree of muscular relaxation. If this is not sufficient to allow easy approximation, the tendon may be lengthened and sutured by one of the methods shown in Fig. 132. If a number of tendons are divided, considerable difficulty may be experienced in accurately uniting the upper and lower extremities of each. This can only be accomplished by free exposure of the parts, an accurate knowledge of topographic anatomy, and identifying the distal ends by traction and observing the action of each upon the structure to which it is attached. The success of tendon suture depends upon the maintenance of an aseptic wound and the occurrence of primary healing. Occasionally surgeons are called upon to unite tendons after complete healing of wounds in which the tendon injury had not been repaired or in which the primary tendon suture had been unsuccessful from infection or other causes. In these cases dense adhesions have generally formed, and the tendons are, as a rule, greatly retracted. This, and the necessity of freshening the edges, necessitate in the great majority of cases tendon lengthening. While the results in these old cases are not usually satisfactory, careful, painstaking work will occasionally furnish a brilliant success.

FIG. 132.



Methods of tendon lengthening.

Dislocation of Tendons.

Dislocation of a tendon occasionally occurs as a result of trauma. The injury is recognized by localized pain and the abnormal position assumed by the tendon during contraction of its muscular fibres. It occurs chiefly in situations in which tendons normally pass through bony gutters or aponeurotic canals. Long-continued rest of the part with complete relaxation of the muscle will occasionally result in a cure. Not infrequently, however, the tendon remains permanently out of place without causing necessarily marked interference with function. If the injury is a source of discomfort to the patient, suture of the aponeurotic structures, the fascia, or even the periosteum over the tendon, may result in its remaining in its normal position.

Myositis, or Inflammation of Muscle-substance.

Myositis occurs as a result of contusions, ruptures, or wounds which have become infected, from extension of an inflammatory process from neighboring structures, or as a symptom of pyæmia. It is said also to occur in rheumatism ; it is occasionally associated with the presence of parasites in the muscle, as the Trichina spiralis ; and, rarely, occurs in connection with a calcification of the muscle, constituting a condition known as *myositis ossificans.* From a surgical point of view these conditions divide themselves into two groups, the suppurative and the non-suppurative. In both, the early symptoms are pain and swelling and stiffness in the muscle. This in the non-suppurative variety generally subsides with rest and the application of wet dressings or hot fomentations. In the suppurative variety the symptoms become more localized ; an indurated area occurs, which later becomes softened and deveolps into an abscess. The muscle most frequently the seat of a suppurative inflammation is the *psoas.* While in the great majority of instances the disease is due to the rupture of a tuberculous abscess of spinal origin into the sheath of the muscle, it has been claimed by certain observers that an infection and suppurative inflammation of the muscle may be occasioned by the migration of colon bacilli from the alimentary canal.

Suppurative myositis occurs not infrequently in typhoid fever and other general infective diseases. Localized muscular abscesses may also occur as a result of farcy, actinomycosis, or blastomycosis.

Treatment.—In the treatment of the suppurative forms of myositis one should draw a sharp distinction between those due to the ordinary pyogenic organisms and those due to tuberculosis, actinomycosis, or blastomycosis. While incision and drainage will be sufficient in the former, complete excision of the lesion when practicable is indicated for the latter.

New Growths of the Muscle.

New growths of the muscle are rare as primary affections, but any of those of mesoblastic origin may occur, as fibroma, lipoma, sarcoma, etc. Secondary deposits from remote carcinomatous or sarcomatous processes occur more frequently.

The **treatment** of tumors of muscular origin should be governed by the same principles which apply to new growths in other tissues.

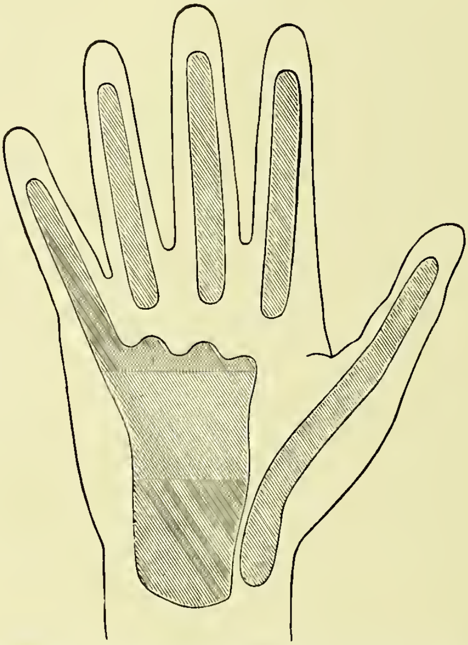
Tenosynovitis, or Inflammation of a Tendon-sheath.

Tenosynovitis in the acute form may occur from severe strain or overuse of a part, from rheumatism, or as a result of infection, generally from a septic wound of the sheath. The subacute and chronic forms of tenosynovitis are generally of tuberculous origin.

In *acute* tenosynovitis from overexertion, the skin over the affected tendon is swollen, red, hot, and tender. Movement of the part is painful. The sheath is distended with fluid and appears as an oblong elastic tumor. These symptoms quickly subside if the part is placed at rest and if hot fomentations are applied. In the *septic* variety the symptoms are at first the same, but later there is a peritendinous induration and often an extending cellulitis. Chills, fever, and malaise may develop, and the pain is often severe. If the process occurs in the flexor tendon-sheath of one of the fingers, the disease is known as the thecal variety of *whitlow* or *felon.* A glance at Fig. 133, which shows the arrangement of the flexor tendon-sheaths of the hand and wrist, will explain why this process when it occurs in the thumb or little finger is so prone to spread upward to the palm, wrist, and arm. In severe cases the suppuration often extends beyond the synovial cavities and involves the cellular planes of the forearm, causing great destruction of tissue and grave sepsis, occasionally resulting in amputation or death. Free incisions and generous drainage, with stimulants and supporting measures when general sepsis exists, constitute the rational treatment. In making the incisions in the fingers care should be taken not to injure the tendon or nerves, and in palmar suppuration the cut should be made directly over the metacarpal bone. As in other septic processes of the hand or arm, Bier's hyperæmic measures are of value.

In the *subacute* and *chronic* forms of tenosynovitis the synovial cavity may be distended with a syrupy fluid in which a number of small oval "melon-seed bodies" are found; there is also some thickening of the sheath. In other cases the sheath is filled with gelatinous matter and pale flabby granulations, a condition which in the joints is spoken of as pulpy degeneration. In still others the sheath is infiltrated and filled with cheesy material and pus. All of these varieties are of tuberculous nature.

Fig. 133.



Showing the arrangement of the synovial sheaths of the palm and fingers. (Gray.)

The **symptoms** of tuberculous tenosynovitis are a slight stiffness of the part associated with an indolent swelling of the tendon-sheath, without pain or tenderness. The overlying skin appears normal. When the part is moved there is a fine characteristic crepitus, which is appreciable on placing the palm of the hand over the affected region.

The **treatment** of this condition should consist in rest and counterirritation by means of blisters or the actual cautery. If this treatment is ineffectual, the sheath should be freely opened and removal of the granulations or caseous material, with as much of the infiltrated tissue as possible, effected with a sharp spoon or scalpel. The application of pure carbolic acid to the interior of the sheath, followed by douching the part with alcohol and sterile salt solution, will in the early forms of the disease enable the surgeon to close the sheath completely with a view to primary union. When this is impossible, the open wound should be dressed with glutol or formalin gelatin, infrequently changed. By the action of this dressing extensive infiltrated areas will often assume a healthy appearance, granulate, and cicatrize.

Ganglion.

The term *ganglion*, or *weeping sinew*, is used to describe a small oval cystic tumor which commonly occurs on the dorsal surface of the wrist. It occurs most frequently in young individuals, and often appears to follow some strain or unusual use of the hand or arm. These cysts lie, as a rule, between the extensor tendons, are often attached to the capsule of the joint or a tendon sheath, but rarely communicate with the synovial cavity. They are occasionally found on the palmar surface of the wrist, along the flexor tendon sheaths, and more rarely about the ankle or foot. Many theories have been advanced to account for these cysts. William Cogswell Clarke has recently investigated the subject very thoroughly, and as a result of his histologic and clinical studies believes that in the great majority of instances ganglia represent degenerative connective-tissue cysts formed in the fibrous tissues about the joints, particularly in the tendon sheaths. In a few instances such tumors may be distended anatomic or adventitious bursæ or hernial protrusions of the synovial membrane through the fibrous capsule. These cysts, as a rule, have thin translucent walls and contain a clear syrup-like or gelatinous fluid. They do not produce any painful symptoms, but patients occasionally will complain of a weakness or sense of fatigue when the neighboring joint is used. Small ganglia situated on the interior of the flexor tendon sheaths of the fingers not infrequently give rise to disturbances of function, of which the *trigger finger* is an example.

Treatment.—The treatment of ganglion should be excision under strictly aseptic precautions, as the operation is likely to open the joint or some adjacent synovial sheath. Subcutaneous puncture followed by pressing the fluid into the surrounding tissue has been recommended. Violently striking the part with a heavy book is often successful.

Compound palmar ganglion is a name given to a distention of the common synovial sheath of the flexor tendons of the wrist. It is usually recognized as an hour-glass swelling, appearing above and below the annular ligament. The disease is a chronic tenosynovitis, and is generally of a tuberculous character. The treatment should be the same as in the other varieties of chronic tenosynovitis.

Fascial Tuberculosis.

While extension of a tuberculous process to the fasciæ and muscles surrounding a given focus is often seen, it is not generally recognized that tuberculosis of the fascia may occur as an independent disease. Primary tuberculosis of the fascia is undoubtedly exceedingly rare, but extensive fascial tuberculosis arising from some insignificant glandular focus, and constituting the chief factor in a given case, is more common. It occurs chiefly in the neck, axilla, groin, and in the retroperitoneal region. The symptoms are those of a slowly progressing inflammatory process with thickening and dense induration of the fascia and intermuscular septa. Pain is rarely a prominent symptom, but soreness and muscular rigidity may be present. The process may remain latent for some time; or it may increase rapidly, break down, and suppurate, leaving one or more sinuses which continue to discharge a thin curdy pus indefinitely.

The **treatment** should consist in thorough exposure of the diseased fascia, and its removal by scissors or the knife. Occasionally extensive granulating areas are present, which if removed with the curette will leave comparatively healthy fascia behind. When this condition is present, removal of the entire fascia is unnecessary. The wound should be treated with a 2 per cent. solution of formalin and united with drainage.

Injecting the sinuses with a 2 per cent. solution of formalin in glycerin may be of value when operative intervention is contraindicated.

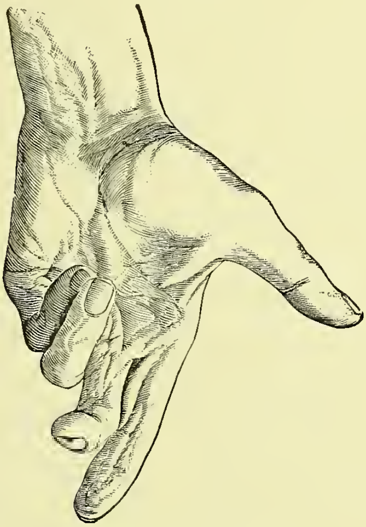
Dupuytren's Contraction.

Dupuytren's contraction is a chronic thickening and contraction of the palmar fascia, especially of the longitudinal fibres which extend from the palm on to the flexor tendon-sheaths.

Little is known regarding the pathology of this affection, which has been ascribed to the effect of trauma, gout, rheumatism, and neuropathic disturbances. It occurs in middle-aged individuals and is more common in men. It begins usually by an inability completely to extend the little or ring finger. Later there is noticed a slight thickening in the palm, which gradually extends toward the finger, and as this band develops it contracts and gradually draws the finger toward the palm. The skin later becomes attached to the fascia and is made to wrinkle as the finger is moved. The disease is progressive and eventually produces great deformity of the hand (Fig. 134).

Treatment.—In the early stages much may be done to prevent progress by massage and repeated bending backward of the affected fingers. The wearing of some apparatus at night which holds the fingers in complete extension is to be advised. Operative treatment of this condition is necessary in all but the earliest cases. Three methods are used: that by multiple subcutaneous division of the bands, recommended by Jacobson; the open method or complete excision of the bands through an incision, as suggested by Kocher; and the plastic method when the adhesion to the skin is too extensive to admit of the other methods.

FIG. 134.



Dupuytren's contraction.

If the first method is employed, the skin of the palm should be softened by soap poultices and hot baths, and rendered sterile by the usual method; the tenotome should be introduced through minute incisions made at places where adhesion does not exist between the skin and fascia, and the band thoroughly divided in several locations. After this division the fingers should be fully extended and held in this position by a splint or some other retention apparatus. If Kocher's method is employed, a longitudinal incision is made over the contracting band, the skin carefully dissected from the thickened fascia, which is then completely removed. The cutaneous incision is united and the wound dressed with the finger extended.

If the involvement of the skin extends over a large area, the following method may be tried: A V-shaped incision is made with the base opposite the base of the affected finger and the apex at the upper limit of the thickening in the palm. The incision should be carried down through the fascia, which should be dissected from the deeper parts. After the finger has been fully extended the wound should be closed, making a Y-shaped line of union.

DISEASES OF THE BURSÆ.

The bursæ are small sacs lined with synovial membrane situated between movable parts. They exist normally in certain situations, as over the patella or olecranon, under the deltoid or semimembranosus muscle, beneath the iliopsoas or patellar tendon; or they may develop as a result of irritation or long-continued pressure on a part. The former are spoken of as the *anatomic bursæ*, the latter as *adventitious bursæ*. Several of the anatomic bursæ, as the subdeltoid, normally communicate with the adjacent joint cavity, others, as the semimembranosus, occasionally have joint connections, while the larger number are wholly independent of joints or other synovial sacs.

Bursitis.

Acute Bursitis.—Acute bursitis may arise from trauma, infection, and, possibly, from rheumatism and gout.

Symptoms.—The symptoms of the traumatic variety are pain, heat, and swelling of the part, with redness of the overlying skin if the bursæ is subcutaneous. Fluctuation is usually present from the increased amount of fluid in its cavity. As a rule, the symptoms subside under rest and conservative treatment. In the infected variety, in addition to the above symptoms, there are œdema and redness of the surrounding area, with fever and general malaise. These cases not infrequently go on to suppuration.

Treatment.—The treatment should consist of rest of the part and the application of an ice-bag or a wet dressing of aluminium acetate or mercuric chloride. If suppuration occurs, a free incision should be made, the cavity curetted, and disinfected. It may then be packed with sterile gauze or partly united and drained by a strand of rubber tissue.

Chronic bursitis may arise from the same causes as the acute affection. In the majority of the cases of chronic bursitis, however, the condition is produced by traumata of a milder grade, but frequently repeated, or by tuberculosis.

In the former class the presence of the constant irritation gives rise to a thickening of the fibrous capsule and the secretion of an excess of fluid which distends the sac and produces a globular tumor.

In the tuberculous cases small, cheesy foci are present on the interior of the sac, which later coalesce, forming necrotic masses, or the lining membrane may be covered with pale, flabby granulations. The fluid may be thin, cloudy, and contain fibrinous flakes, or it may become purulent from the presence of a mixed infection. In many cases the "melon seed" bodies found in chronic tenosynovitis are present.

Symptoms.—The symptoms of chronic non-tuberculous bursitis are simply the presence of a painless globular swelling over the region of a bursa and some stiffness and limitation of the motions of the part. In the tuberculous cases there is in addition often a moderate amount of muscular atrophy in the affected limb, with evidences of impaired bodily health. Here as in other suspected tuberculous lesions the tuberculin test is of value.

Treatment.—The treatment should consist in counterirritation by means of the Paquelin cautery, blisters, or painting with tincture of iodine. If this fails, aspiration of the fluid followed by pressure by an elastic bandage may be tried. The injection of a few drops of pure carbolic acid has been recommended, after removal of the fluid. In rebellious cases, causing discomfort or impairment of function, complete removal or incision and packing is to be recommended. When the disease is known to be tuberculous in character, complete excision of the bursa constitutes the best treatment.

Subdeltoid, or **subacromial bursitis,** is one of the most frequent pathologic conditions about the shoulder-joint which the surgeon is called upon to treat. Much confusion in the past has existed in the differentiation of this condition from chronic arthritis of the shoulder-joint, muscular rheumatism, and neuritis. This confusion has in a large measure been cleared up by Codman's masterly thesis on the subject.[1] The disease is generally traumatic in origin, and most frequently follows a blow or fall on the point of the shoulder.

Symptoms.—The symptoms in the acute stage are pain in the shoulder, especially at night, the presence of a tender point just below the acromion and to the outer side of the bicipital groove, inability to abduct the arm through an arc of more than ten degrees without corresponding movement of the scapula, and marked pain on external rotation. In the subacute and chronic varieties there is less pain, but more stiffness and limitation of motion. In the adhesive type motion is very much restricted, not through muscular spasm, as in the acute cases, but by fibrous adhesions within the bursa. In chronic cases without adhesion, motion may be comparatively free, but painful in certain directions, producing jerky or irregular movements.

Treatment.—The treatment of the acute cases should consist in rest with the arm at a right angle with the body, followed by massage and passive motion. In the adhesive cases massage, forcible rupture of the adhesions under general anæsthesia, or open operation with division of bands is to be recommended. Codman's operation consists in an incision two or three inches in length from the anterior border of the acromion downward, parallel with the bicipital groove. The fibres of the deltoid are separated and the bursa incised. The adhesions are brought into view by various movements of the arm, and divided at their attachment to the bursal walls; after which the wound is closed, the arm abducted to 90 degrees, and held by a plaster-of-Paris splint. In a number of instances reported by Codman this slight operation has been followed by an almost immediate restoration of function.

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[1] Read before the Massachusetts Medical Society, June 9, 1908.

Housemaids' knee is an inflammation of the prepatellar bursa. This bursa lies directly over the lower part of the patella and the upper part of the patellar ligament. There is another bursa under the patellar ligament which is often the seat of inflammation. This bursa is pear-shaped, the apex pointing downward; when enlarged, it bulges on each side of the tendon.

Miners' elbow is an inflammation of the bursa over the olecranon. It occurs often as an acute affection, and results in considerable cellulitis in the tissues around the bursa; occasionally the bone becomes diseased.

Weavers' bottom is a name applied to inflammation of the bursæ over the tuberosities of the ischium. It is a painful affection and often rebellious to treatment.

Inflammation of the bursæ about the great trochanter or under the psoas tendon may cause symptoms simulating hip-joint disease. Inflammation of the bursæ under the hamstring tendons, under the head of the gastrocnemius muscle, or of the pretibial or prepatellar bursæ, may be mistaken for synovitis of the knee. Inflammation of the bursa beneath the Achilles tendon, sometimes called *Albert's disease*, is a painful affection which often is overlooked. The symptoms are local tenderness just above the attachment of the tendon to the os calcis and pain on walking, especially when the body is raised on the toes. Inflammation of the bursa over the metatarsophalangeal joint of the great toe, or *bunion*, is due to pressure of ill-fitting shoes, and is generally associated with a condition of hallux valgus.

The **treatment** of all these conditions is rest and cold applications or wet dressings for the acute attacks, with incision and drainage if suppuration occurs.

CHAPTER XIII.

INJURIES AND DISEASES OF THE NERVES.

Contusions.

A NERVE-TRUNK may be contused as a result of a blow, a fall, or any other trauma, but such injuries are rare from the fact that, as a rule, the nerves are so situated as to be protected from external violence. The nerves most exposed to such injuries are the ulnar at the elbow, the cords of the brachial plexus, the facial, the sciatic, the external popliteal, and the anterior tibial. In many instances the nerve-lesion is associated with a fracture or dislocation.

The **symptoms** of contusion of a nerve-trunk are pain, a feeling of tingling, numbness, or the sensation of pins and needles in the region supplied by its sensory branches, with weakness or paralysis of the muscles. The symptoms are generally temporary unless the injury gives rises to a neuritis or degeneration of the nerve-fibres.

Treatment other than rest is rarely necessary for this condition. If, however, there is delay in restoration of function, counter-irritation over the injured area, massage, and electricity to the region of its distribution are to be employed.

Wounds of Nerve-trunks.

These injuries are of fairly common occurrence. They are caused by fractures, accidents with knives or other sharp instruments, cuts from glass, gunshot wounds, and, not infrequently, accidental division takes place during surgical operations. As a result of such injury a nerve-trunk may be completely divided or it may be simply lacerated. When a nerve-trunk is completely divided, certain changes occur in its peripheral portion, beginning on the second or third day and continuing for three or four weeks. These changes are in the nature of a degeneration, and consist in a gradual destruction of the myeline and the axis-cylinders. This causes atrophy of the nerve and degenerative changes in the muscles supplied by it. These changes are recognized by the "reaction of degeneration" in the affected muscles, which is indicated by certain alterations in the reaction of the muscles to the electric currents, the chief change being a failure of the muscle to respond to the faradic, and occasionally an exaggerated response to the galvanic current. The proximal end of a divided nerve-trunk becomes gradually thickened and presents a bulbed extremity, made up of connective tissue and coiled axis-cylinders. Occasionally in uninfected wounds when the ends of a divided nerve are separated by a short interval only, repair will take place with more or less complete restoration of function, as evidenced by a return of sensation after neurotomy or even neurectomy for neuralgia. Repair, however, takes place much more often and in a far more satisfactory manner if the divided ends are early approximated by open operation and suture. This regeneration of injured or divided nerves is a most important surgical fact, and the nature of the process has been extensively studied. All observers agree that it is possible only in the peripheral nerves, and is due to the presence of the neurilemma. Considerable difference of opinion exists regarding the nature of the process, many holding that the new axis-cylinders develop wholly in the central trunk and pass downward in the sheath of the peripheral portion, which acts as a scaffolding or conduit for their transmission. Other observers believe that new axis-cylinders develop in the peripheral portion of the divided nerve from a proliferation of the neurilemma cells, but that these axis-cylinders remain immature and functionless until they unite with the axis-cylinders of the central end of the nerve, when regeneration becomes complete. All agree, however, that the condition necessary to a restoration of function is early and accurate coaptation of the divided ends.

The **symptoms** of complete division of a nerve-trunk are total paralysis of the muscles supplied by it, and if it be a mixed nerve, anæsthesia over the region supplied by its sensory fibres. The anæsthesia is generally incomplete and its exact limits difficult to determine, owing to a mixed nerve-supply in most cutaneous areas, and also to the fact that a region of total anæsthesia when present is apt to be surrounded by a zone of diminished sensibility. The reaction of degeneration is to be looked for in motor nerves.

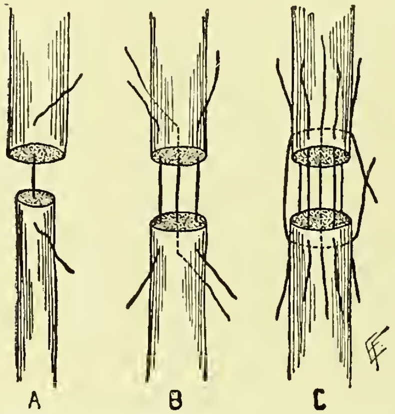
Certain trophic disturbances follow the division of a nerve, generally some time after the accident. These consist first in hyperæmia over the region of its distribution, which later is succeeded by anæmia of the part. The skin becomes shiny, and atrophied (glossy skin); the nails are roughened, present furrows, and crack; the hairs drop out or lose their color and lustre; and there may develop an extreme burning sensation which causes great suffering.

If the injury to the nerve is simply a wound or laceration without complete division, the symptoms may be those of a contusion with more or less sensory and motor paralysis, generally associated with considerable pain at the point of injury and extending over the course of the nerve.

Incomplete division of a nerve with continued irritation of the wounded portion, as from a contracting cicatrix, is apt to be followed by an exaggerated degree of pain and trophic disturbance.

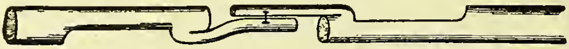
Treatment.—Whenever an important nerve-trunk has been divided, the treatment should be union of the divided ends by suture at the earliest possible moment, as restoration of function depends in great measure upon the promptness with which the reparative processes are inaugurated. Doubtless much improvement often follows late secondary operations, but in these cases the improvement is apt to be largely in the sensory or trophic disturbances, as the degenerated muscles rarely give evidence of much restoration of function. In recent injuries the parts should be rendered aseptic by the usual methods, the wound sufficiently enlarged to give a satisfactory exposure of the divided nerve, which should be brought together and held by one or more catgut or fine silk sutures. If the ends are widely separated, they should be well drawn out and stretched sufficiently to allow easy approximation without tension. This is always possible in fresh wounds in which there has been no loss of tissue. After the nerve has been sutured it should be covered by a layer of muscle, fascia or fat, to prevent cicatricial tissue forming about the line of union, and the wound closed with a view to primary healing. The success of the operation depends very largely upon the absence of infection. If the suture has been successful, an improvement in the trophic symptoms will be first observed, later a gradual return of sensation. The sensation at first will be abnormal in character, as a tingling or burning in the extremity, followed by a gradual progress toward the normal. Motion returns later, and may not be complete for many months. If considerable time has elapsed since the injury, and the primary wound has healed, it is still desirable to expose and suture the nerve, although the result will probably be less perfect than in operations undertaken at an earlier period. An incision should be made over the anatomic line of the nerve, and its divided ends located, separated from the surrounding adhesions, and drawn toward each other. The bulbed extremities are to be excised and the ends approximated, as in the earlier operation. If the ends cannot be brought together without tension, the incision should be extended, and a further attempt made to stretch the nerve, both from above and below. If this succeeds, a retention suture of chromicized catgut should be introduced above and below, from one-quarter to one-third of an inch from the divided ends, and drawn tightly enough to bring the ends in easy apposition; they should then be united with two or three fine catgut or silk sutures, preferably passed only through the sheath (Fig. 135). If coaptation is impossible, the nerve may be grafted by the insertion of a section of nerve from a freshly killed rabbit or dog, or one removed from a recently amputated limb; or the nerve may be lengthened by flaps cut from the upper and lower portions and united as in tendon suture (Fig. 136). Passing numerous strands of catgut between the divided ends by means of a fine curved needle has been recommended, also enclosing the strands within a tube of decalcified bone or a small section of a formalinized artery which also surrounds the nerve for a short distance above and below. In all of these plans the intermediary substances simply serve as conductors of the new axis-cylinders, and afford protection against the formation of scar tissue between the divided ends of the nerve.

Fig. 135.



Methods of nerve suturing: *A*, *B*, Sutures passing through sheath and part of nerve; *C*, sutures through sheath, reinforced by relaxation suture through entire nerve.

Fig. 136.



Nerve suture with lengthening.

That these are the essential elements in successful nerve suture is evidenced by the experiments of Forsman, who found that if he placed the divided ends of a nerve in a straw tube regeneration took place, but was slow. If, however, the ends of the nerve were connected by a thread, or the lumen of the straw filled with brain substance, the repair was far more rapid.

After healing of the operative wound the affected region should be treated by massage, hot and cold douches, and electricity. The judicious use of these measures will often retard degenerative changes in the muscles.

Compression of Nerve-trunks.

Permanent compression of a nerve-trunk is generally caused by contraction of a cicatrix, pressure of a displaced bone or callus following dislocation or fracture, or to growth of a tumor or aneurism. The symptoms are variable. There may be simply the numbness and muscular weakness of a contusion, or the impairment of function may progress until total paralysis of sensation and motion occurs. Pain is often a prominent symptom. The treatment should consist in removal of the cause of the pressure. Dissecting the nerve free from an encircling cicatrix or mass of callus, or the removal of fragments of bone or a neighboring tumor, will often bring about a permanent cure, although a return of sensation and motion may be delayed, as after more severe injuries.

Among the most frequently observed *traumatic palsies* are those of the facial muscles due to injury to the seventh nerve from fracture at the base of the skull, those of the extensor muscles of the forearm due to pressure on the musculospiral nerve, from fracture of the humerus, ulnar paralyses from fractures of the internal condyle of the humerus, and paralyses of the leg muscles from fractures about the knee-joint, causing pressure on the popliteal nerves.

Neuritis.

Neuritis is an inflammation of the sheath of a nerve-trunk and of the connective tissue between its fasciculi. It arises from a variety of causes some of which are not well understood. Trauma, wound infection, pressure, general sepsis, the infectious diseases, gout, rheumatism, alcoholism, lead-poisoning, and other chronic toxæmias are generally enumerated among the causes of this condition. The disease may be limited to a single trunk, or a very large number of nerves may be affected, giving rise to a serious condition known as *multiple neuritis*. In the former there is generally present well-marked thickening and œdema of the trunk, in the latter, chiefly degenerative changes.

Symptoms.—The symptoms of neuritis vary with the cause of the disease and the acuteness of the attack. A neuritis following an acute trauma or due to extension of a septic process to the tissues of the nerve, may give rise to severe pain radiating over the area of distribution of the nerve, with localized tenderness, and to the presence of a hard tender cord if the nerve is superficially located. In less acute cases the symptoms may be simply a numbness or the sensation of pins and needles over the affected area, followed by a gradually developing anæsthesia with trophic disturbance. In motor nerves there will be muscular paresis or paralysis, often with atrophy and the reaction of degeneration. In certain cases of acute neuritis the process is an ascending one, and may eventually involve a plexus or the spinal cord. When the inflammation reaches the plexus, symptoms will appear in the other branches of distribution; when the cord becomes involved, symptoms of myelitis are present.

The **treatment** of neuritis is almost entirely medical, and should consist in absolute rest of the part if the pain is severe, with counterirritation over the course of the nerve. Later the use of massage, baths, and electricity is to be recommended to favor the processes of repair and to prevent wasting of the muscles. Constitutional conditions, as gout, rheumatism, or syphilis, should receive appropriate treatment. If sepsis or pressure is found to be an etiologic factor, it should be removed surgically. Another surgical measure which is frequently of benefit in chronic cases, especially where trophic ulcerations are present, is nerve-stretching. It is desirable to prevent secondary contractions by the use of splints or other mechanical apparatus.

Neuralgia.

Neuralgia is a condition characterized by severe radiating pain following the course of a sensory or mixed nerve, unaccompanied by evidences of inflammation or systemic disturbance. The pain may be continuous or intermittent. When intermittent, the paroxysms may occur as often as every two or three minutes, or the intervals may be prolonged to several hours or days. Each paroxysm may be characterized by a sudden, acute, darting pain, which may be the cause of convulsive movements in the neighboring muscles (especially in neuralgia of the fifth nerve), and may as suddenly cease; or the pain may begin with a slight discomfort which gradually increases in severity until the most acute suffering is produced, and then suddenly or gradually subsides. Patients suffering from neuralgia may have a series of attacks extending over a period of several days or weeks and then be free for a number of months.

The **causes** of neuralgia are obscure. Apparently it is often due to malaria, rheumatism, gout, syphilis, or lead-poisoning, but quite as often it occurs without association with any of these toxæmic conditions. General ill health from any cause, and especially anæmia, seem often to be associated with neuralgia. Of the local causes, trauma, irritation of one of the peripheral branches of a nerve, pressure from any cause, and exposure to cold and dampness, are the most frequent. Faulty nutrition of a nerve trunk or ganglion from an obliterating endarteritis of the minute vessels of the sheath not infrequently leads to degenerative changes which may account for the impaired function of the nerve. This has been observed particularly in the Gasserian ganglion in severe cases of tic douloureux.

Diagnosis.—In the diagnosis of neuralgia one should remember that much confusion has arisen by the careless manner in which the terms neuralgia and neuritis have been used. While both conditions give rise often to chronic pain over the distribution of certain sensory or mixed nerves, one should limit the term neuritis to those cases in which some gross evidence of an inflammatory process is present, as tenderness or thickening over the course of the nerve, more or less continuous pain, aching or discomfort, muscular weakness, trophic disturbance, or evidence of degeneration. In pure neuralgia none of these symptoms are present, the pain is sharp, stabbing, and paroxymal, with intervals of complete freedom from abnormal sensations. Pressure over a nerve which is the seat of neuralgia will often give a certain measure of relief, while the same pressure over the nerve in a case of neuritis will increase the suffering. It must be admitted, however, that in certain cases both conditions seem to be associated.

Treatment.—In the majority of instances the treatment of neuralgia falls to the care of the physician rather than the surgeon. Iron, quinine, salicin, cod-liver oil, and good food, associated with the local use of heat, menthol, or other soothing applications, will be found useful in the treatment of most cases in which the cause is obscure. Large doses of aconite or strychnine have been advised, and hydrotherapy or a change of climate will often be of great benefit. For the immediate relief of pain the use of phenacetine, acetanilid, antikamnia, or some of the other coal-tar analgesics, or opium in some form, is frequently necessary. Galvanism is often effectual. When these measures are unsuccessful and the suffering is great, surgical intervention is indicated. Neuralgia is treated surgically by the removal of a direct cause, as the pressure of a tumor, cicatrix, or foreign body upon the nerve; or by the removal of a reflex cause, as the treatment of carious teeth, intranasal conditions, disease of the accessory sinuses, or of ovarian, renal, rectal, vesical, or urethral sources of irritation; by nerve-stretching in neuralgia of a mixed nerve; by neurotomy, neurectomy, or the injection of alcohol, osmic acid, or other chemical substances into the nerve trunk with a view to producing degenerative changes, in disease of a purely sensory nerve.

Nerve-stretching.—This is applicable to disease of any accessible nerve-trunk, but is employed most frequently in *sciatica.* The nerve should be exposed by an incision, carefully separated from the neighboring tissues, surrounded by the bent finger, a strand of gauze, or a blunt hook, and progressively increasing traction made for four or five minutes, after which the wound is closed and an aseptic dressing applied. Temporary improvement almost always follows this procedure, and permanent relief is sometimes obtained. The sciatic nerve may also be stretched by the dry method, by placing the patient on his back and forcibly flexing the thigh on the body, the leg being held in complete extension. Roman von Baracz, in a recent article, asserts that in obstinate cases of sciatica adhesions frequently exist between the trunk of the nerve and the tissues at or just within the sciatic notch, and advises exposing the nerve at this point and separating the adhesions with the finger. Bennet and Niordano have successfully resected the posterior roots of the nerve in rebellious sciatica.

Neurotomy and *neurectomy* have been largely employed in the treatment of neuralgia. Division of a nerve-trunk gives instant relief to neuralgic pains in its branches, but recurrences are frequent after this operation, due to a subsequent union of the divided ends. Removal of a section of a nerve-trunk, leaving a considerable interval between the divided ends, which may be filled with sterilized paraffin, rubber tissue, or some other unirritating substance, is more successful, but the symptoms recur not infrequently after these procedures.

Tic Douloureux.—Of all the different forms of neuralgia, the cases most likely to fall to the care of the general surgeon are those affecting the various branches of the fifth cranial nerve, and grouped under the term *tic douloureux*. If the disease is limited to one of the three divisions of the nerve, peripheral stretching, neurotomy, or neurectomy may be practised. Of these procedures, neurectomy only is to be recommended. If the disease affects all three divisions of the nerve, or if the disease has resisted all other rational methods of treatment, and the symptoms are so severe as to warrant the patient assuming a considerable risk to obtain relief, intracranial neurectomy or removal of the Gasserian ganglion is to be recommended.

Neurectomy of the First Division of the Fifth Nerve.—The supraorbital nerve is exposed by a horizontal incision just below the superior margin of the orbit, dividing the tissues down to the supraorbital notch, through which the nerve passes. The nerve is then grasped by an artery-clamp and separated from the surrounding orbital fat, which is depressed by a flat retractor. Traction is then made upon the nerve until the supratrochlear branch is exposed. The nerve is divided behind this branch and the peripheral portion removed. The wound is then closed and an aseptic dressing applied.

Neurectomy of the Second Division.—Expose the infraorbital nerve by a curved horizontal incision along the lower margin of the orbit. The nerve will be found passing out of the infraorbital foramen lying on the levator labii superioris muscle. It should be grasped with an artery-clamp or a piece of stout silk tied around it. The orbital periosteum and fat should be retracted and the canal broken open by a chisel, the nerve drawn outward, divided as far back as possible, and the peripheral portion removed, after which the wound should be united and dressed. A far more complete but more difficult operation is that suggested by Carnochan. Expose the infraorbital region by a T-incision, the perpendicular arm extending from the infraorbital notch to a point near the angle of the mouth, the horizontal arm along the inferior margin of the orbit. Next, isolate the nerve as it emerges from the foramen and secure it with a piece of strong silk; then divide all tissues down to the bone and arrest bleeding. Next remove a portion of the anterior wall of the antrum with a chisel or trephine, and then remove a small button from the posterior wall with a one-half inch trephine, exposing the sphenomaxillary fossa. The infraorbital canal is then opened from below by a chisel or bone-forceps, throughout its entire length, after which the nerve is drawn downward into the trephine-opening through the posterior wall of the antrum, and followed backward to the foramen rotundum. It should be divided as near the foramen as possible, and the entire extracranial portion removed, including the sphenopalatine or Meckel's ganglion. Considerable venous hemorrhage will accompany the manipulations in the sphenomaxillary fossa, which is best controlled by packing. The packing may be allowed to remain in place two or three days, and after its removal the cutaneous wound can be sutured without anæsthesia, as all sensation in the part has been abolished by the operation.

Neurectomy of the Third Division.—Make a curved incision around the angle of the jaw, dividing only the skin and superficial fascia; isolate the two main branches of the facial nerve and Stenson's duct, which lie on the fascia covering the masseter muscle, retract these structures and separate the fibres of the masseter muscle, exposing the ascending ramus of the jaw. Next trephine this just above the angle and locate the nerve as it enters the dental canal. Divide it as close to the canal as possible, grasp the proximal end with forceps, and follow it upward for an inch or more, and divide with blunt scissors. Unite the cutaneous incision and apply an aseptic dressing.

As recurrences after these peripheral neurectomies were of frequent occurrence, Thiersch, in 1889, advocated a more thorough removal of the nerve-trunk by evulsion. His method consisted in exposing the nerve by the usual method, seizing it with a pair of forceps, and, by a slow twisting motion, to evulse both the central and peripheral portions.

Moschcowitz has recently reviewed the subject, and has demonstrated by personal observation and by referring to numerous reports of others, both clinical and experimental, that the cause of a recurrence of the symptoms after all peripheral operations is a regeneration of the nerve, which can be demonstrated by a re-exposure of the site of the original operation. He logically concludes that the only method of preventing a recurrence is to introduce an effective barrier to the passage of the newly developed nerve-fibres through the bony canal. For this purpose he suggests the use of blunt-pointed silver tacks, which can be firmly driven into the various foramina, or of silver foil or dentist's amalgam, with which a bony canal can be plugged.

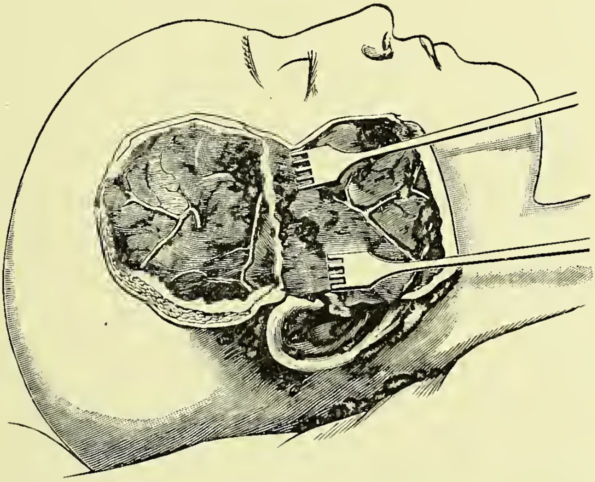
The Injection Methods.—The injection into a bony nerve canal or, still better, into the nerve-trunk of 1 c.c. of a 1 per cent. solution of osmic acid has been followed by relief in many cases reported by Bennett, Murphy, and others. The method consists in exposing the nerve at the foramen of exit and injecting the solution by means of a hypodermic syringe. The contact of the acid blackens the tissues, and for that reason the surrounding skin should be protected.

The injection of 80 per cent. alcohol into and about the nerve-trunks has recently been advocated by Schlosser and others. The results which have followed this method have been encouraging. Kiliani has reported 55 personal cases, of which 47 were definitely relieved. He makes no claim to permanency of result, but suggests that recurrences can be easily treated in the same manner. The injections are made by means of a syringe and a long, blunt, or acutely bevelled needle. No anæsthesia is required, and, by a reasonable degree of anatomic knowledge and skill all of the peripheral foramina and even the rotundum and ovale can be reached. About 1.5 c.c. of 80 per cent. alcohol, with or without the addition of a small amount of cocaine, is injected into the foramen. If successful, the injection should immediately be followed by a burning pain over the area of distribution of the nerve, later by numbness and anæsthesia.

When all peripheral methods fail, or in cases of severe neuralgia, involving two or all three branches of the nerve, one of the intracranial methods is to be recommended. Three operations are to be considered: Removal of the Gasserian ganglion, division of its sensory root, or section of the second and third branches with the interposition of a folded strip of rubber protective tissue or some other substance to prevent regeneration.

Intracranial Neurectomy or Removal of the Gasserian Ganglion.—The Gasserian ganglion may be exposed by the Hartley-Krause operation. Make an omega-shaped incision extending from the anterior extremity of the zygoma upward and backward along the temporal ridge to its posterior extremity (Fig. 137). Carry the incision down to the skull, arrest hemorrhage, and divide the bone in the line of this incision, using the Hartley chisels, a surgical engine, or the Gigli saw, through several small trephine-openings, care being taken not to wound the dura. The flap, consisting of the bone adherent to the soft parts, is then raised with periosteal elevators and broken off along the line of its base, which should be just opposite the zygoma. The middle meningeal artery may be injured by separating the bone from the dura and should be secured by a fine silk ligature passed beneath the dura with a small curved needle. The lower margin of the opening into the skull may be extended by removal of the thin plate of bone with rongeur forceps. When all hemorrhage is arrested and the position of the head is so adjusted as to admit the greatest amount of light, the dura is very slowly and very gently raised from the middle fossa of the skull by the fingers or a smooth gauze sponge, until the foramina (rotundum and ovale) are exposed. When these are freely exposed, the dura and brain are well retracted by means of a flat highly polished spatula, and the second and third divisions of the nerve drawn upward on a small blunt hook and divided as close to the bone as possible. The proximal portions of the two nerves are then secured by two artery-clamps, the dura divided between the nerves along the thin curved edge,

Fig. 137.



Osteoplastic flap turned down, exposing the dura mater and middle meningeal artery. The brain and dura are then pushed upward so as to expose the petrous bone with the ganglion lying on its apex. (Hartley.)

made prominent by upward traction on the clamps, and the sheath of the ganglion opened. The ganglion is removed by twisting the two clamps so as to tear the branches and the attached ganglion backward away from the untouched first division. The difficulties of this operation are chiefly from severe and long-continued venous hemorrhage from small and large dural trunks emptying into the cavernous sinus or from a wound of the sinus itself. This generally can be controlled by gauze packing, irrigating the wound with hot salt solution, or both combined. The operator should be provided with a large number of conveniently sized strips of gauze, which may be used for packing the apex of the wound, allowed to remain a minute or two and then removed. Raising the patient to the sitting posture, and the application of adrenalin to the bleeding point, will sometimes be of service. After removal of the ganglion and arrest of the hemorrhage the bone-flap should be replaced and secured with silk-worm gut sutures, a small rubber tissue drain being left in one angle of the wound. The eye should be protected by a small layer of sterile cotton covered by several layers of gauze, the wound dressed, and the whole held in place by a snug head bandage of starched crinoline.

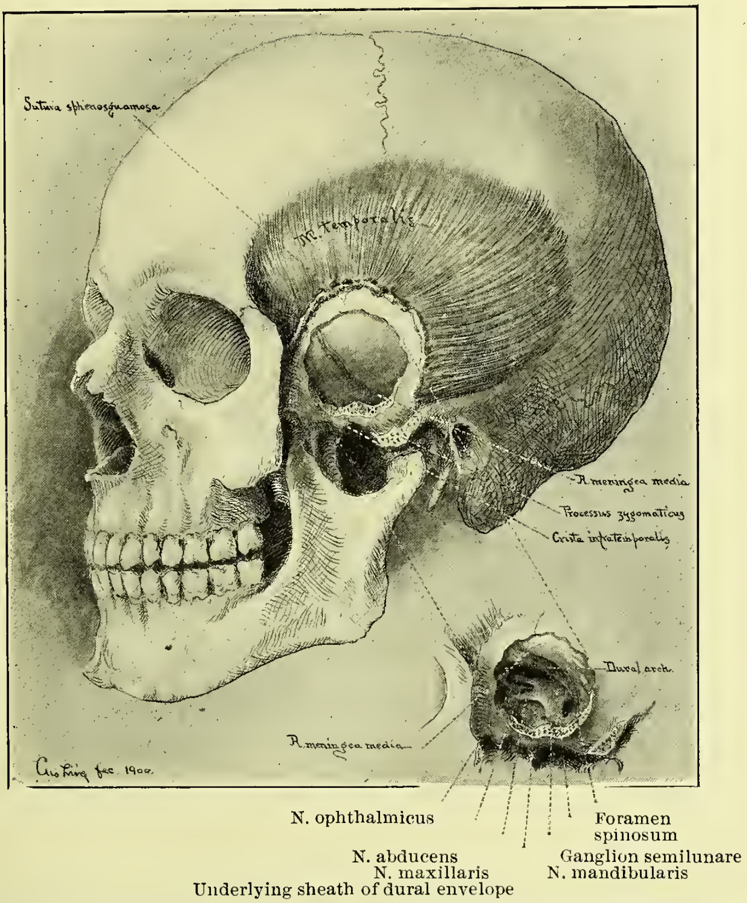
Harvey W. Cushing exposes the ganglion by a lower incision similarly curved. The temporal muscle and zygoma are divided in the line of the incision, and both are turned downward, exposing the lower portion of the temporal fossa of the skull. This is broken through with a chisel and the opening enlarged with the rongeur forceps. The dura with the middle meningeal artery is gently retracted and the ganglion exposed, as in the Hartley operation. The advantages of this route are that there is little or no risk of wounding the middle meningeal artery, and as the opening in the skull is nearer the ganglion, its exposure can be accomplished with a minimum amount of retraction and compression of the brain (Fig. 138).

By means of this incision one is also able to expose the second and third divisions as they emerge from their foramina, and thus perform an extracranial neurectomy.

Spiller and Frazier, in 1901, suggested as a substitute for complete removal of the ganglion simply section of the posterior sensory root. The ganglion is exposed by the Hartley or Cushing method, the foramen ovale recognized, and an incision made in the dura from the foramen backward over the sensory root, great care being taken to avoid wounding the middle meningeal artery as it emerges from the foramen spinosum. The dura is next stripped from the posterior portion of the ganglion and the sensory root until the latter is sufficiently exposed to enable the operator to surround it with a blunt hook. The root is then drawn forward and divided, evulsed, or a small portion resected. The wound is then closed, as described above, and an aseptic dressing applied.

Cushing has recently adopted this method, and believes, with Frazier, that the procedure is quicker, safer, and as effectual as removal of the entire ganglion. Frazier states that it is possible in most of these cases to avoid division of the motor root.

Fig. 138.



Showing relations of the middle meningeal artery to the operative foramen before and after elevation of the dura and exposure of the ganglion. (Cushing.)

A still less hazardous operation is the one described by Abbe in the *Annals of Surgery*, Jan., 1903. It consists in exposing the ganglion, severing the second and third divisions, and preventing reunion by placing a folded piece of rubber protective tissue over the foramina. This, in cases in which the neuralgia is limited to the second and third divisions of the nerve, is often effectual. Mixter substitutes dentists' amalgam for the rubber tissue, and is strong in his endorsement of the procedure.

In exposing the ganglion for any of these procedures, if the Cushing method is used, some embarrassment occasionally will be encountered by the presence of an elevated ridge of bone just external to the foramen ovale and somewhat anterior to it. This in brachycephalic skulls is not infrequently so well marked as to hide the ganglion when approached by the low operation. When present, the summit of the elevation can be chiseled off without difficulty and a perfect exposure secured.

When the entire ganglion is removed, trophic changes are apt to appear in the cornea, which, unless great care is used, lead often to ulceration and destruction of the eyeball.

To avoid this complication, the eye should be protected against all irritation or trauma during the operation, and at its completion should be douched with boric acid solution, closed, covered with a pad of sterile cotton, and protected by a separate bandage. This dressing should be removed daily after the first forty-eight hours and the eye carefully washed and resealed.

Tumors of the Nerves.

Tumors arising from nerve-trunks are rare. They are generally of mesoblastic origin, and arise from the sheath of the nerve or the connective tissue between the fasciculi. The tumors most frequently encountered are the fibromata or fibroneuromata, myxomata, and sarcomata. A fibroma growing from the sheath of a nerve may produce no symptoms, as the nerve-fibres may pass along one side of the tumor as a well-recognized cord and be in no wise affected by its growth. Occasionally, when the pressure on the neighboring parts produces compression of the nerve-fibres, pain, numbness, and muscular disturbances are produced. This is especially true if the tumor develops in a bony canal. Fibromata growing from the interfascicular areolar tissue may cause a separation of the individual fibres of the nerve, which may be spread out over its surface.

A well-recognized form of fibroma is the *painful subcutaneous tubercle*, which often appears along the branches of the cutaneous nerves, especially on the lower leg. The condition known as *molluscum fibrosum* is in many instances a group of fibromata growing from the cutaneous nerves. *Fibroneuromata* are tumors which contain nerve-elements as well as fibrous tissue, and are commonly observed in the bulbed extremity on the proximal end of a divided nerve-trunk.

Sarcomata and myxomata are rare, and are recognized by the usual characteristics of these growths.

In regard to **treatment**, the same rules apply as in tumors of other tissues. Malignant tumors should be removed as early as possible; innocent tumors giving rise to painful symptoms should also be removed. Small fibromata occurring on important nerve-trunks, not giving rise to symptoms and showing no tendency to increase in size, should not be molested.

Tic Convulsif.

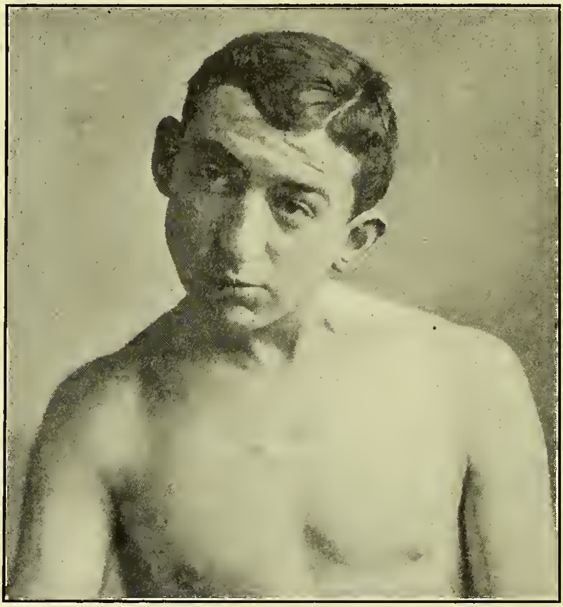
This affection is a spasmodic twitching of the facial muscles due to irritation of the seventh nerve. Its cause is obscure. It is often associated with severe neuralgia of the fifth nerve. If the disease is of a severe type and causes much discomfort, stretching the seventh nerve will sometimes afford relief. The nerve is best exposed by the method of Baum, which consists in a curved incision beginning behind the ear opposite the external meatus and carried downward and forward around the lobule toward the angle of the jaw. The anterior border of the sternomastoid muscle is exposed and retracted backward, and the parotid gland drawn forward. This exposes the digastric muscle, along the upper border of which the nerve will be found. It is raised on a blunt hook and the tension maintained for two or three minutes, after which the wound is closed. In the severest cases, or in those in which nerve-stretching has not afforded relief, division of the main trunk of the nerve at its exit from the stylomastoid foramen and anastomosis with the spinal accessory or hypoglossal is indicated. Successful cases have been reported by Cushing and Kennedy.

Torticollis.

Torticollis is a spasmodic contraction of the sternomastoid muscle alone or associated with other muscles of the neck, producing an abnormal attitude of the head with or without convulsive movements (Fig. 139). The disease occurs both as a congenital and an acquired affection. In the congenital variety the cause is often a hæmatoma of the sternomastoid muscle or a prenatal myositis, with subsequent contraction from atrophy of the muscular fibres and the formation of dense connective tissue. In the acquired variety the symptoms are often apparently due to some central irritation transmitted through the nerves supplying the affected muscles. It is frequently associated with neurasthenia, hysteria, and other neuroses; occasionally it is thought to follow trauma. In the congenital myelogenous variety, cervical scoliosis and asymmetry of the skull and face are frequently present. Cases seek relief from the surgeon only after medical means have been exhausted.

Treatment.—The surgical treatment consists in tenotomy, myotomy, stretching or division of the spinal accessory nerve, or division of the posterior branches of the upper three cervical nerves. In the congenital cases, where the muscle is found to be converted into a dense fibrous band, the operation of Mikulicz is to be recommended. This consists in exposure of the muscle by a longitudinal incision, division of its sternal and clavicular attachments, and complete removal of the degenerated portion, if necessary, as far as the mastoid process. After closure of the wound the position of the head should be overcorrected and held by a plaster-of-Paris cast.

Fig. 139.



Torticollis. (Whitman.)

In the spasmodic variety nerve-stretching or neurectomy is indicated. The spinal accessory nerve can be exposed by a three-inch incision along the anterior margin of the sternomastoid muscle, beginning at the tip of the mastoid. The incision is carried down to the deep fascia, which is divided, and the space between the muscle and the carotid sheath exposed by retracting the tissues. The nerve will be found just below the posterior belly of the digastric muscle at a point where the latter crosses the transverse process of the atlas, and is identified by following it downward to the sternomastoid muscle, which it enters at a point opposite the angle of the jaw. The nerve is raised on a blunt hook and may be stretched or a portion resected. The nerve also may be reached by an incision along the middle of the posterior border of the muscle as it passes into the trapezius. Bailey has pointed out that complete paralysis of the sternomastoid and trapezius occasionally follows this operation, owing to the entire nerve-supply being transmitted through the spinal accessory trunk. If the posterior muscles of the neck are largely involved, the trapezius, splenius, complexus, and trachelomastoid, the posterior branches of the first, second, and third cervical nerves should be divided. This is accomplished through an incision five or six inches in length extending from the occiput vertically downward about an inch from the spinous processes. The incision should divide the skin, fascia, and trapezius muscle; the edges of the muscle should then be well retracted and the splenius and complexus divided transversely. The posterior muscular branches of the three upper cervical nerves will be found beneath the complexus. These should be resected and the divided muscles united with catgut sutures. After closure of the wound the head should be placed in its normal position and retained by means of a plaster-of-Paris dressing. After healing of the wound, massage, regular exercises, hydrotherapy, and general tonic measures should be employed.

Perforating Ulcer of the Foot.

Perforating ulcer of the foot is an indolent ulcer occurring generally under the ball of the great toe, and showing no disposition to heal even under the most favorable conditions. The causes of this disease are, first, a condition of more or less complete anæsthesia of the skin, associated with frequently repeated traumata; some interference with the trophic nerve control of the part, or both of these conditions may be combined. The disease is, therefore, often associated with tabes, syringomyelia, and spina bifida. It is also occasionally encountered in diabetic or alcoholic subjects who suffer from neuritis. The surrounding skin is often anæsthetic; the ulcer may extend to the bone and not infrequently results in necrosis.

Treatment.—The treatment consists in rest and elevation of the part, hot poultices or wet dressings, with currettage of the ulcer and removal of the thickened skin, followed by packing with balsam or iodoform gauze. If these measures fail, stretching the sciatic or internal popliteal nerve may be tried. In the more obstinate cases amputation may be necessary.

Resection of the Cervical Sympathetic for Glaucoma, or Exophthalmic Goitre.

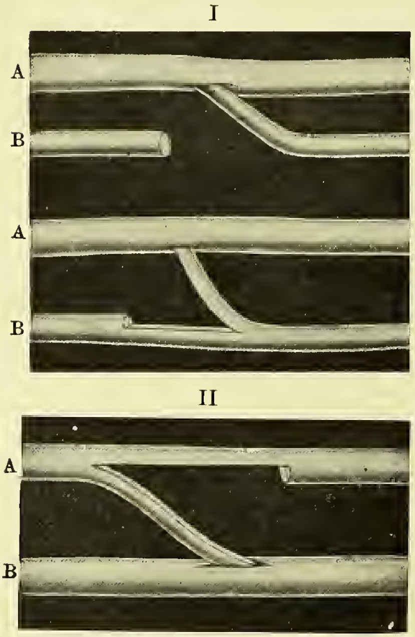
This operation is still on trial for these and other conditions. Sufficient data are not at hand to allow us to determine its value.

The upper three cervical ganglia with the connecting cord may be exposed by an incision made along the entire length of the posterior border of the sternomastoid muscle. After division of the deep fascia and retraction inward of the muscle the carotid sheath is exposed, beneath which will be seen the gray cord of the sympathetic nerve. This should be followed upward and downward until the ganglionic enlargements are found and the cord divided above the first and below the third ganglion.

Nerve Anastomosis.

The success which attended nerve suture in traumatic cases naturally led to the employment of nerve anastomosis with a view to restoring function in peripheral nerves which have been rendered functionless by trauma or disease (Fig. 140).

Fig. 140.



Nerve anastomosis: A, Intact nerve; B, paralyzed nerve; I, lateral anastomosis (peripheral implantation); II, lateral anastomosis (central implantation).

Facial Paralysis.—As *facial palsy* is one of the most frequent and most disfiguring of the motor palsies, this was one of the first to receive the serious attention of surgeons. In 1895 Mr. Ballance, of London, performed the first facio-accessory anastomosis. Since that time numerous cases have been reported by Cushing, Körte, and others, with satisfactory restoration of function in the paralyzed nerve. Facio-hypoglossal anastomosis is advocated by Frazier, Taylor, and others, who report equally satisfactory results. In all of these cases during the period of gradual restoration of function, associated movements occur in the region formerly supplied by the active nerve trunk, when voluntary motion is attempted in the facial group of muscles.

Operations should not be undertaken in Bell's palsy or non-traumatic paralysis of the facial nerve for at least six months after the onset of the symptoms, as cases are known to recover spontaneously up to that period. In traumatic cases the earlier the operation is performed the better, although recoveries are reported by these operations many years after the injury.

The technic of the operation is comparatively simple. The region is exposed by a longitudinal incision along the anterior border of the sternomastoid muscle, the facial trunk recognized at its exit from the stylomastoid foramen, and followed well into the substance of the parotid gland until its bifurcation is reached. The spinal accessory is next exposed for a distance of two or three centimetres proximal to its entrance into the under surface of the sternomastoid muscle. The two nerves are then divided and an end-to-end suture practised, as shown in Fig. 141, the proximal end of the accessory being joined to the distal extremity of the facial. If the hypoglossal is employed, the technic is a little more difficult, as the nerve lies deeper. Some surgeons prefer to employ only a part of the functionating nerve for the anastomosis; others graft the peripheral end of the facial into the accessory or hypoglossal, making an end-to-side anastomosis. In all cases the union should be protected by wrapping it in Cargile membrane, a bit of fascia, muscle, or fat. As success depends very largely upon primary union of the wound, the operation should not be undertaken unless the surgeon can command trained assistants and the conditions necessary for a perfect aseptic technic.

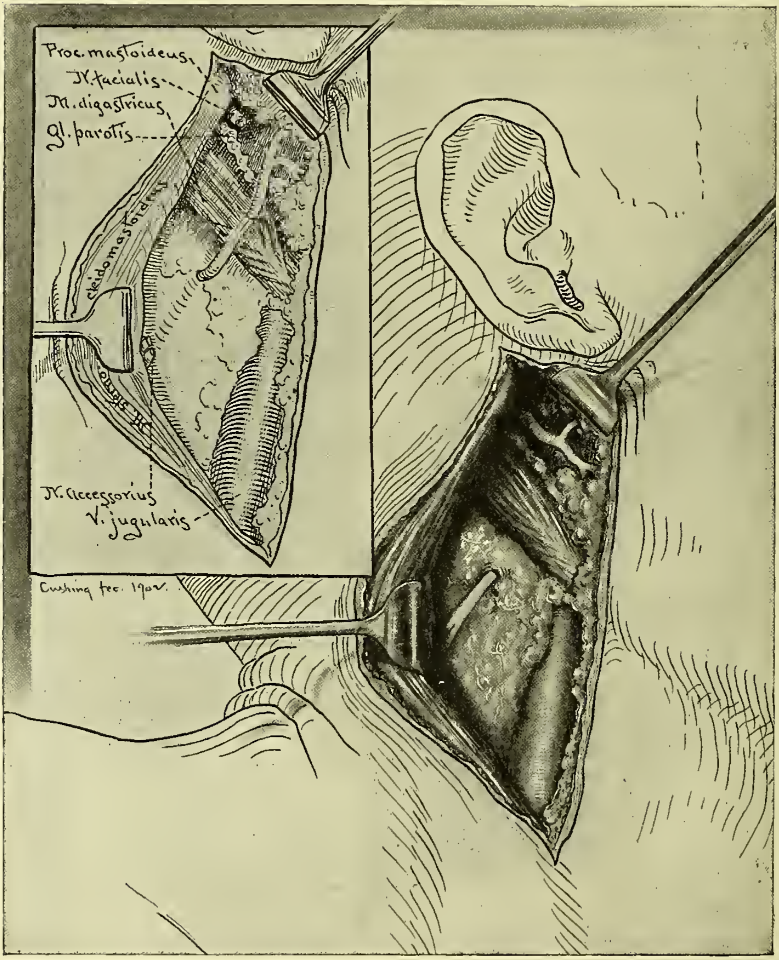
Brachial nerve paralysis of traumatic origin occurs most frequently as a birth palsy. It is more rarely met with in later life as a result of an injury which forcibly separates the head and shoulder, or as the result of a gunshot or stab wound. In some cases of birth palsy the roots of the plexus are actually torn apart; in others, the nerve trunks are so stretched as to cause a rupture of the sheath and some of the fibres, with hæmorrhage and the later formation of dense scar tissue, which effectually prevents nerve regeneration.

In the milder cases only the fifth root is injured; in the more severe injuries, the sixth, seventh, and eighth roots; or, in the severest, the entire plexus may be torn from the spinal column. In all of these cases a more or less complete paralysis of the upper extremity results. A study of Fig. 142 will enable one to estimate the extent of a given injury from the grouping of the paralyzed muscles.

In the treatment of brachial birth palsy, at least six months should elapse before operation is performed, as a spontaneous recovery occurs in a certain proportion of the cases.

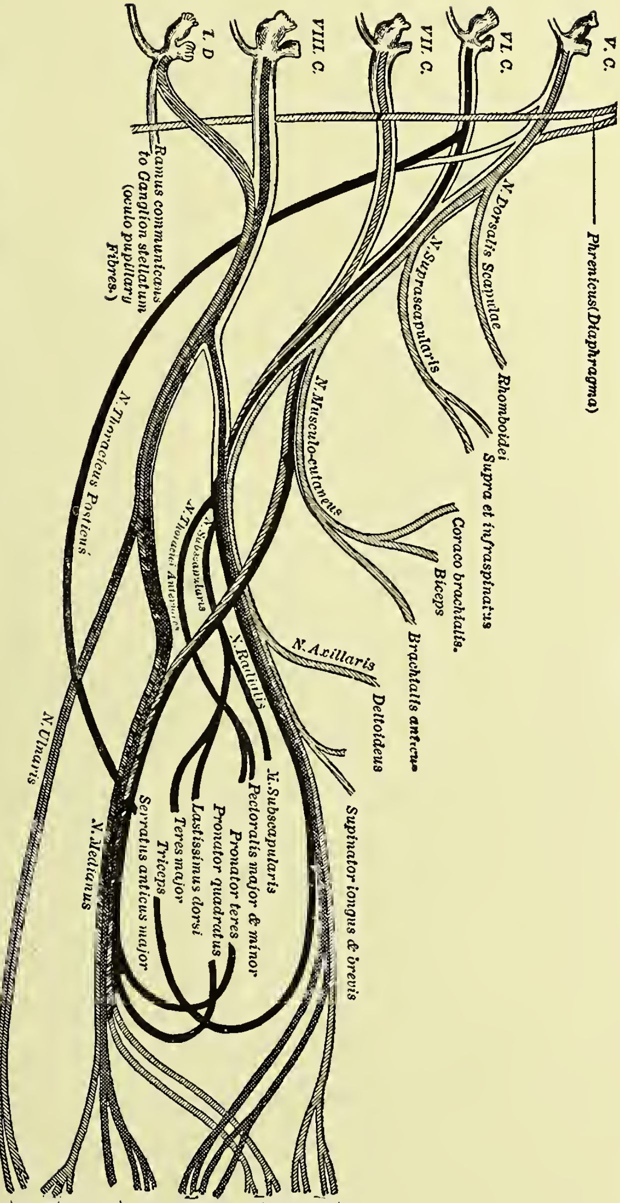
The operation consists in exposing the plexus by an oblique incision from the posterior border of the sternomastoid outward to the acromio-clavicular articulation. The incision is gradually deepened, the omohyoid muscle retracted or divided, and the plexus exposed, as seen in Fig. 143. The further steps of the operation

Fig. 141.



Illustrating method of facio-accessory anastomosis. (Harvey Cushing.)

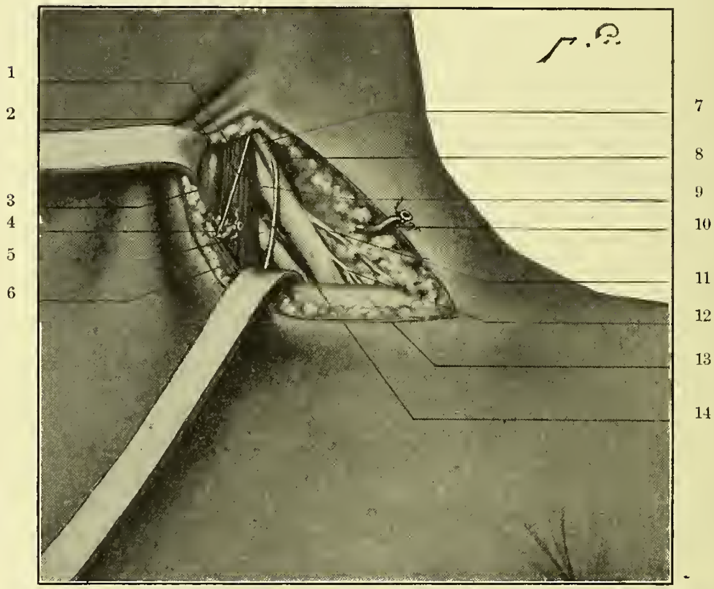
FIG. 142.



Semidiagrammatic scheme (Kocher) to show the formation of the brachial plexus and the nerve supply to the muscles of the upper extremity. (Taylor, Clark, and Prout.)

are to be determined by the lesions found. If one or more of the roots or trunks are completely severed, an attempt should be made to suture them after removal of their bulbed extremities. If this is impossible, an attempt should be made to anastomose live proximal trunks and the functionless distal branches. When the plexus is apparently intact, indurated areas should be sought for and excised, and suture, or anastomosis, carried out to restore function. After these procedures have been completed, the wound should be closed and dressed, and the head and shoulder approximated to relieve all tension on the anastomosed nerves. Successful operations have been reported by Kennedy, Taylor, and others.[1] The nature of the injury is such that a complete restoration of function is seldom to be expected, and the number of carefully reported cases is, as yet, too small to enable one to make any definite statements regarding prognosis. Enough has been demonstrated, how-

FIG. 143.



1, Scalenus anticus muscle; 2, phrenic nerve; 3, internal jugular vein; 4, transversalis colli artery divided; 5, seventh cervical root; 6, omohyoid muscle; 7, fifth cervical root; 8, scalenus medius muscle; 9, sixth cervical root; 10, transversalis colli artery; 11, suprascapular nerve; 12, nerve to subclavius muscle; 13, clavicle; 14, nerve to scalenus anticus muscle. (Taylor, Clark and Prout.)

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[1] For a review of the literature of the subject the reader is referred to the admirable paper of Clark, Taylor, and Prout, *American Journal of the Medical Sciences*, October, 1905.

ever, to give rise to much encouragement in the surgical treatment of these otherwise hopeless and distressing conditions.

Infantile paralysis has recently been successfully treated by nerve anastomosis; also paralysis of muscles of the upper and lower extremities, due to destruction of nerve-trunks from compound fractures, lacerated wounds, and other forms of trauma. The principles to be followed in all of these cases are the same as in the conditions described above.

When possible, the distal trunk of the functionless nerve should be anastomosed into the undivided trunk of a normal nerve by drawing the freshly divided end of the peripheral nerve into a longitudinal slit in the normal trunk, and securing it in place by sutures passed through its sheath.

CHAPTER XIV.

INJURIES AND DISEASES OF THE BRAIN AND SPINAL CORD.

ALTHOUGH the brain and spinal cord are perhaps the best protected organs in the body, owing to their bony coverings, they are not infrequently the seat of grave injury. These injuries in the majority of instances are accompanied by fractures of the skull, or fractures or dislocations of the vertebræ. The bony injuries will be considered in Chapters XXVII. and XXVIII., in which it will be shown that in themselves they present no more serious features than fractures in other localities, the danger of such injuries being in direct proportion to the extent of lesion in brain or spinal cord.

INJURIES AND DISEASES OF THE BRAIN.

Since many of the surgical diseases of the brain are traumatic in origin, and as in a large number of these conditions both general and local symptoms are produced, they are difficult to classify in a satisfactory manner. We shall, however, consider first the generalized lesions of the brain, or those resulting in symptoms of general cerebral disturbance, and later the localized lesions, or those characterized chiefly by focal symptoms.

Concussion of the Brain.

Concussion of the brain may be defined as a condition of impaired or suspended cerebral function due to a sudden and violent jarring of the brain without gross structural lesion. The cause of this condition may be a fall or blow on the head with or without fracture, or a fall upon the buttocks, the force being transmitted through the vertebral column. Many theories have been propounded to account for the symptoms of concussion. The most recent investigations, however, show that in pure concussion the only structural change may be a condition of shrinkage, changed outline, and chromatolysis of the ganglion-cells similar to that produced by exhaustion or starvation.

The **symptoms** of concussion vary greatly in degree. An example of the simplest form would be the slight giddiness and visual disturbance commonly spoken of as "seeing stars," which one frequently experiences for a moment after a sudden blow on the head. A more severe type would be illustrated by the sudden suspended consciousness and complete muscular relaxation which follow a "knock-out" blow on the angle of the jaw. Recovery from such a blow usually takes place in a few seconds, but for several minutes thereafter the individual seems dazed and not quite in touch with his surroundings. Later a feeling of weakness and indisposition to physical or mental exertion may be present for several hours. In the severe forms of concussion the period of unconsciousness may be prolonged for several hours, although it is rarely complete. As a rule, the individual can be aroused by extraordinary efforts on the part of his attendants, and may occasionally make some brief reply to questions frequently repeated. When undisturbed he lies with eyelids partly open, the face is pale and expressionless, the extremities are cold and often bathed with perspiration, the respirations shallow and quiet; the pulse is frequent, feeble, and often intermittent; the temperature of the body is subnormal; the sphincters may be relaxed. The condition is practically one of shock in which the impaired cerebral function is rather more marked than usual. After a variable period reaction occurs, generally indicated by nausea and vomiting, after which the color improves, the pulse becomes stronger, consciousness returns, and the patient slowly recovers. A condition of apathy and physical weakness may persist for days or even weeks. Occasionally, reaction does not occur. The patient then becomes progressively weaker, unconsciousness gradually deepens into coma, and death results. It is probable, however, that in these cases some lesion other than simple concussion is present, although focal symptoms may remain absent.

Treatment.—The treatment of concussion of the brain is practically the same as that of surgical shock, and consists in absolute rest with the head lowered. Hot-water bottles should be applied to the extremities and friction or hot blankets to the surface of the body. Hot drinks, stimulating enemata, intravenous infusions, and the hypodermic use of strychnine, whiskey, and atropine are to be employed if the shock is profound and the heart action fails. After reaction has occurred rest in a darkened room, light diet, cathartics, and an ice-bag to the head are indicated if any temperature or symptoms of cerebral irritation occur.

Contusion or Laceration of the Brain or its Membranes.

This condition is always associated with concussion of the brain, the symptoms of the latter appearing first and masking those of contusion, which manifest themselves only after the patient begins to recover from the concussion. The causes of contusion or laceration of the intracranial contents are the same as those of concussion, but are more severe in character. In the great majority of instances contusion is associated with fracture of the skull, more particularly with those fractures involving the base. The injury may be confined to the immediate vicinity of the blow, or, as frequently happens, it may appear at a point directly opposite; or in severe cases it may be generally distributed throughout the brain and its coverings. The lesions may consist in bruises or tears in the membranes or of the brain substance with hyperæmia, hemorrhages, œdema, and thrombosis of the vessels. If sepsis does not form a part of the process, or if the character of the lesions is such that death does not follow the injury, secondary changes occur as a result of the processes of repair. Adhesions form between the meninges and cortex, scar tissue develops, areas of softening occur, and cysts may result from the incomplete absorption of blood-clots.

The **symptoms** are quite different from those due to concussion. They are expressed best by the term *cerebral irritability.* The patient, after recovery from the temporary unconsciousness of the accompanying concussion, appears restless, the eyes are tightly closed, and the features drawn as if in pain. He lies in a position of general flexion, the head is inclined toward the chest, the body rests upon the side, with the thighs drawn upward and the legs flexed. The arms are bent at the elbows, the wrists are flexed, and the fists clenched. The head is buried in the pillow, and he resists with angry exclamations and gestures any attempt to move him from this position or to make a physical examination. He lies in this semiconscious state for an indefinite period, occasionally, in alcoholic cases, becoming wildly delirious and making attempts to get out of bed. The face is flushed, the skin dry, the temperature elevated, the pulse rapid and full. Food is swallowed when placed in the mouth; the urine and feces are passed in the bed. Lumbar puncture often reveals the presence of blood in the cerebrospinal fluid. This condition may persist for days or weeks, after which the symptoms may gradually improve and complete recovery ensue. Occasionally, however, there is a long and perhaps permanent period following convalescence, in which the patient complains of headache, loss of memory, or other mental or physical defect. In other cases evidences of meningitis or meningo-encephalitis develop, which may rapidly result in fatal compression or sepsis. In these cases death generally occurs during the first five days. If the patients survive this period, recovery may be looked for in a majority of instances (Bailey). Among the secondary or late results of such injuries may be mentioned loss of memory, lack of will power, an inability to concentrate the attention, irritability of temper, muscular paresis or paralysis, sensory disturbances, epilepsy, and insanity.

Treatment.—The treatment of contusion or laceration of the brain should be to prevent or overcome septic infection and to insure rest and quiet for the patient. Compound fractures or scalp wounds should be carefully disinfected and treated in the usual manner. The patient should be kept in a darkened room on low diet, with an ice-bag applied to the head. He should have a tactful attendant, who should administer food at such times and in such quantities as will be borne by the stomach. Judicious restraint is often necessary when a constant attendant cannot be secured. The question of operative intervention in these cases of brain injury has been considerably discussed of late. Cushing, Frazier, and others have strongly advised early operation in cases where there is reason to believe that much blood is extravasated with a view to removal of clots and to prevent the results of subsequent œdema and vascular changes. In this way many of the grave secondary symptoms can be avoided. When the point of greatest injury is over the vault of the skull, or where the symptoms strongly suggest that as the region of maximum injury, an osteoplastic flap may be turned down, the dura opened, the clots removed, bleeding vessels secured, and the dura repaired. If much intracranial tension exists, the bone-plate should be removed and the scalp sutured to allow a relief of pressure. As most of these injuries are associated with fractures of the base, and as in these cases the greatest damage to the brain is apt to be in the middle fossa of the skull, Cushing's decompression operation in the temporal region is to be advised with a view to removal of extravasated blood and the relief of pressure.

Compression of the Brain.

When the cranial cavity is encroached upon by depression of its walls, the introduction of foreign bodies, hemorrhages upon the surface of the brain or within its substance, by the presence of inflammatory exudates or by the growth of tumors, a certain group of symptoms is produced which indicate a condition of generalized compression. Moderate increase in the volume of the brain from hyperæmia or other causes, or a limited symmetric diminution in the size of the cranial cavity, may produce no symptoms, for the reason that the change is compensated by driving a certain quantity of cerebrospinal fluid from the ventricles and subarachnoid space into the more elastic membranous spaces of the spinal canal. When, however, the degree of pressure is greater, damage to the cerebral structure results both from the direct effect of such pressure itself and from the nutritive changes which are occasioned by the resulting anæmia.

Compression of the brain to a degree equal to one-sixth of its volume is invariably fatal. Pressure to a less extent is often fatal, and always serious. Moderate pressure may be tolerated for a short period without untoward results; but if unrelieved, nutritive changes occur which leave permanent lesions or produce a fatal termination.

Symptoms.—The symptoms of compression are those of complete annihilation of all cerebral functions except those of the medulla. When absolute the patient lies in a state of profound coma, from which nothing will arouse him or produce the slightest sign of consciousness. The pulse is full, strong, and slow; the blood-pressure increased; the temperature is elevated; the respirations are slow, deep, and stertorous; the cheeks are puffed out with expiration and retracted with inspiration; the reflexes are abolished; and there is no response to painful sensations. The pupils are widely dilated, often asymmetrically, and do not respond to light; changes in the eye-grounds, varying from a slight œdema to a pronounced choked disk, are invariably present, and are a definite index of the degree of cerebral compression. If the symptoms develop slowly, at first there may be evidences of cerebral irritation, such as severe headache, restlessness, vomiting, emptying of the bladder and rectum, contracted pupils, delirium, convulsions, and paralysis of various groups of muscles. As the pressure increases these symptoms gradually give way to apathy, drowsiness, stupor, and coma. In traumatic cases, symptoms of compression developing immediately after the injury are generally due to depressed bone; coming on after a few hours, to hemorrhage; after a few days, to œdema or pus.

Prognosis.—The prognosis is always grave. The occurrence of a high temperature, an increasing blood pressure, and a progressively deepening coma generally means early death unless the cause of the pressure is speedily removed. Respiratory and cardiac failure are the common causes of the fatal termination.

Treatment.—The treatment of this condition consists in removal of the cause when that is possible. If the symptoms point to depressed bone as a causative agent, the region of the injury should be exposed and any fracture thoroughly explored and depressed fragments removed or elevated. The early occurrence of focal symptoms may often give valuable data in determining the point at which an exploratory operation should be made. The old method of blood-letting in cases of cerebral compression with a view to lowering blood-pressure is to be condemned, as the heightened blood tension is a conservative effort on the part of the vasomotor mechanism to force the blood into the brain rendered anæmic by the intracranial pressure. In the presence of symptoms of deepening coma with a gradually mounting blood-pressure, as evidenced by the character of the pulse and the findings of the ophthalmoscope and manometer, the indications are for craniotomy for relief of pressure and the removal of clots. As many of these cases are associated with fracture of the base of the skull and lacerations of the brain and its meninges, the Cushing decompression operation on one or both sides is to be recommended. It must be borne in mind, however, that even after the relief of pressure, symptoms of sepsis may appear, the infection gaining entrance by means of fissures leading from the middle ear, pharynx, nasal cavity, or one of the sinuses. This danger may, in a small measure, be avoided by careful disinfection of the nasopharynx and external auditory canals. After infection has occurred its severity occasionally may be mitigated by drainage, rendered possible by the temporal decompression operation, or by the internal administration of urotropin.

Septic Inflammation of the Brain and its Membranes.

Infection of the intracranial structures may take place through an open wound, by the bloodvessels, or by the lymphatics. The commonest cause is trauma; the others, in the order of their frequency, are middle ear disease, disease of the frontal sinuses or ethmoidal cells, suppurative lesions of the scalp, and metastases from other remote septic foci. In fractures at the base of the skull the infection generally takes place through a fissure which communicates with the nasal, pharyngeal, or aural cavity. In compound fractures of the convexity, infection is often carried inward by hairs or bits of clothing driven in by the fracturing force. In middle ear disease and inflammations of the accessory nasal sinuses infection is usually carried by direct extension (necrosis of bone) or through the lymphatic or venous channels.

In traumatic cases, in which general infection occurs, and in many cases of spreading infection from local causes, the inflammatory process involves all of the intracranial structures, meninges, brain substance, sinuses, and nerve-trunks. In these cases it is often impossible to distinguish clinically between the different lesions, the symptom-complex suggesting only a diffuse septic inflammation which leads rapidly to a fatal termination. In milder infections which spread less rapidly one is often able to make a more specialized diagnosis.

Meningitis.

Two forms of meningitis occur: *pachymeningitis*, or inflammation of the dura, and *leptomeningitis*, or inflammation of the pia.

Acute external pachymeningitis is an inflammatory process situated between the inner surface of the skull and the dura mater. It is usually the result of compound fracture of the skull which has not wounded the dura. When such a wound becomes infected, which often occurs from tightly closing a scalp wound without drainage, a collection of pus forms on the outer surface of the dura which may extend for a considerable distance, separating the dura from the skull and giving rise to a tumor which causes symptoms of local brain-pressure. The disease is recognized by pain, throbbing, œdema of the scalp, headache, evidences of septic intoxication, and possibly focal brain symptoms. Opening the wound, removing a button of bone, evacuating the pus, irrigation and drainage of the cavity, will usually result in a cure unless the infection is carried by the dural veins to one of the sinuses, in which case sinus thrombosis and pyæmia may develop.

Chronic internal pachymeningitis is a rare condition, the etiology of which is obscure. It is characterized by a localized plastic inflammation occurring on the inner surface of the dura. The plastic exudate becomes highly vascular; hemorrhages may occur, giving rise to symptoms of local or general compression. The process is an extremely slow one, is rarely diagnosticated, and has not received the attention from surgeons which its importance merits. Munro, of Boston, has recently demonstrated that surgical relief is sometimes possible. The symptoms are, as a rule, chronic headache with occasionally well-marked focal brain symptoms. The treatment should be an exploratory osteoplastic resection of the skull, with removal of the clots and exudate, and subsequent closure of the wound.

Acute Septic Leptomeningitis.—This is the usual form of meningitis which occurs after trauma and from extension of a septic process from a neighboring focus. It occurs also as an epidemic disease—*cerebrospinal meningitis*—and as a tuberculous process. It is, however, only with the septic form that the surgeon has to deal. Septic meningitis may begin in the pia covering the convexity of the brain or at the base. In either case the process extends rapidly and eventually involves the greater part of the membrane, including that portion lining the ventricles. The surface of the brain is injected, œdematous, and covered with fibrin; the cerebrospinal fluid is at first cloudy, but later becomes distinctly purulent and distends the subarachnoid space and ventricles, causing marked pressure on the brain-substance.

The **symptoms** at first are those of cortical irritation—severe headache, with intolerance of light and sound, fever, chills, a rapid pulse, and stiffness of the muscles of the neck. The pupils are contracted; there are wild delirium, spasmodic contraction of the muscles, and occasionally general convulsions. As the disease progresses the irritative symptoms gradually give way to those of paralysis of the cortical centres. There is stupor; the delirium becomes low and muttering; the pupils dilate; and symptoms of cerebral compression appear. In meningitis limited to the region of the base, the early headache and delirium may be wanting, the symptoms are those of general sepsis and cerebral irritation, followed by paralysis of the cranial nerves and cerebral compression. In doubtful cases lumbar puncture may be practised, and the fluid withdrawn examined for pus and micro-organisms.

The **prognosis** is extremely grave. Death may occur at any time, from two to ten days from the onset of the symptoms.

The **treatment** should consist in rest in a darkened room, cold to the head, cathartics, low diet, and measures to control the early pain and delirium. The original wound, if one is present, should be enlarged and one or more other openings made in the skull for irrigation and drainage of the subdural space. This treatment thoroughly carried out has occasionally been followed by recovery. Ventricular drainage will sometimes be indicated. In the early stages of the infection, urotropin is to be recommended.

Encephalitis.

This condition is frequently the accompaniment of a septic meningitis, especially if the latter is engrafted upon a condition of laceration of the brain. It occurs in gunshot or other penetrating wounds, and as an extension of a superficial process to the deeper parts by the veins or lymphatics. The cerebral tissue is swollen, injected, œdematous, and softened. Circumscribed areas of necrosis may occur, and abscesses develop if the duration of the disease is sufficiently long. The symptoms may be those of an acute septic meningitis, or they may be less severe, and simply those of local cortical irritation followed by pressure-symptoms, or they may gradually pass away and recovery take place.

The termination of encephalitis may be in death from sepsis or the accompanying meningitis, in recovery, or in an acute or chronic cerebral abscess.

Abscess of the Brain.

Abscess of the brain results from the less virulent forms of encephalitis. Acute abscess of the brain gives rise to localized pain, fever, epileptic seizures, and general sepsis. If the abscess is situated in the motor area, the convulsions are of the Jacksonian type and paralyses of certain muscles may result. In chronic abscess located in one of the silent areas of the brain there may be no symptoms, and the condition may remain unrecognized for months or years. Generally, however, there is some pain or discomfort over the region of the disease; the pulse is slow and full; the temperature normal, subnormal, or slightly elevated. Slow cerebration, loss of memory, difficulty in concentrating the attention, and a certain hesitancy in speech may be the only symptoms. Percussion of the skull over the region of the disease may be more painful than over a corresponding area on the sound side. Optic neuritis may be present. As abscess of the brain results most frequently from middle ear disease; it is generally located in the temporosphenoidal lobe or in the cerebellum, the infection in the former instance taking place through the roof of the tympanum and antrum of the mastoid; in the latter through the posterior wall or from a sinus thrombosis. The location of abscesses in other silent regions may be suggested by scars and evidences of previous injury. In temporosphenoidal abscess the pain may be near the ear, and if the collection of pus is large the motor area may be affected, giving rise to focal symptoms. In cerebellar abscess there may be ataxia, stiffness of the neck muscles, and nystagmus. As a rule, however, there are few localized signs in chronic abscess of the brain.

Treatment.—When abscess of the brain is suspected, the skull should be opened by a large trephine or by the osteoplastic method, the dura incised, and the surface of the cortex examined for bulging, softening, or absence of pulsation. A grooved director should next be introduced in several directions, and when pus is reached the opening should be enlarged by introducing a pair of closed dressing-forceps and withdrawing them with the blades slightly separated. The cavity, if large, may then be explored by the finger, irrigated with salt solution, packed lightly with gauze, and the wound partly closed. During these manipulations the subdural space, unless it is closed by adhesions, is sure to be contaminated with the pus, and should be drained by pledgets of gauze introduced between the dura and surrounding cortex. The pus of chronic, long-standing brain abscesses is likely to be sterile. The subsequent treatment should consist in cleanliness and frequent gentle packing the cavity until it fills with granulations.

Sinus Thrombosis.

This practically always results from a septic inflammation of the walls of a sinus, the infection usually being brought to the sinus by a neighboring osteomyelitis, or septic thrombosis of one or more small tributary veins. The sinus becomes filled with a thrombus, which also becomes infected, and later may soften, disintegrate, and be carried by the circulation to any part of the body, giving rise to metastatic abscesses and pyæmia. While any of the cerebral sinuses may become infected, the one most commonly diseased is the lateral sinus from extension of a septic process of the middle ear through the mastoid cells to its sigmoid portion. Next in frequency comes the cavernous sinus from direct infection from the sphenoidal cells or from a septic thrombosis of the veins about the orbit or forehead. Thrombosis of the longitudinal sinus or of the petrosal are rare.

The **symptoms** of infective thrombosis of the lateral sinus are usually preceded by a history of an acute exacerbation of an old middle-ear disease with tenderness over the mastoid and fever. Following this there is a severe constant localized pain, with marked elevation of temperature and a rapid, feeble pulse. The fever is marked by notable remissions; there may be chills and sweats. If the process extends to the jugular vein, there will be pain and induration over the region of the upper part of the jugular in the neck. If the cavernous sinus is involved, there will be exophthalmos and chemosis, with congestion of the lids and dilatation of the retinal veins. In advanced stages of sinus thrombosis evidences of involvement of the cranial nerves may be present. Thus in involvement of the lateral sinus and jugular vein, hoarseness, dysphagia, or paresis of the muscles supplied by the spinal accessory; in cavernous thrombosis, paralysis of the ocular muscles, hyperæsthesia over the distribution of the trigeminus, or choked disk may be present. At a later period in the disease evidences of metastatic accidents manifest themselves, and the patient gradually succumbs to general septic infection.

Treatment.—This should be undertaken at the earliest possible moment, and should consist in freely exposing the mastoid region by a curved incision back of the ear, supplemented if necessary by a horizontal incision at right angles to the first. The mastoid antrum and cells should be freely opened by a chisel or rongeur forceps, and the sinus located and opened. The clots should be gently removed first from the direction of the torcula and then from the jugular extremity until blood flows. The sinus should then be disinfected with hydrogen peroxide, irrigated with salt solution, and packed with sterile gauze. If the thrombus extends well into the jugular vein, it should be ligated below the disease, opened, and if possible irrigated from above. The wound should then be partly closed, ample provision being made for drainage of the tympanum and mastoid antrum.

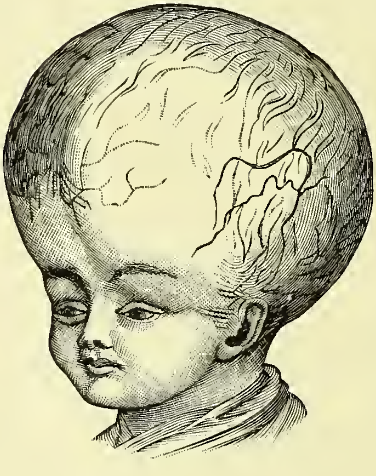
Thrombosis of any of the other cerebral sinuses, if considerable, may be treated in the same manner; but, as a rule, the symptoms are obscure and the condition remains unrecognized until it is beyond the help of the surgeon.

As stated above, in many of these cases of intracranial sepsis the surgeon is unable to make an exact diagnosis, as two or more of these processes may be present at the same time. In such cases the necessary operations are at first in the nature of exploratory procedures, the subsequent steps of the operation depending upon the pathologic lesions found.

Hydrocephalus.

Hydrocephalus is an abnormal collection of fluid within the cranial cavity. In *external* hydrocephalus the fluid is in the subdural space, in *internal* hydrocephalus the fluid is in the ventricular cavity. The condition may be congenital or acquired. It is, however, surgically important only in infancy and childhood. In the congenital variety, which is usually internal, the ventricular distention may be due to some obstruction in the aqueduct of Sylvius which prevents the fluid secreted in the lateral ventricles from passing downward through the fourth ventricle and the foramina of Magendie into the subarachnoid space, although Cushing, who has recently given the subject much attention, found no such obstruction in the majority of his cases. In these cases the accumulation of fluid may be enormous, distending the cranial cavity to five or six times its natural size (Fig. 144). The bones are widely separated, the brain is converted into a thin-walled sac, and all surface-markings are obliterated. The child shows little or no mental activity, and death often occurs at an early period. In less severe cases, when life is prolonged, the child may be an idiot or imbecile. The acquired variety may be due to some new growth pressing on the iter or the veins of Galen, or to meningitis. The external form is not infrequently associated with chronic internal pachymeningitis.

Fig. 144.



Hydrocephalus.

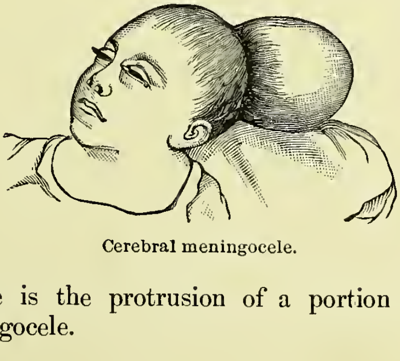
The **treatment** of this condition is unsatisfactory. External pressure is of no avail. Ventricular tapping gives only temporary relief, and permanent external drainage is practically always followed by sepsis. Draining the ventricular cavity into the subdural space would seem to be the rational plan of treatment, and if it could be accomplished at an early period before permanent pressure-effects are produced it might prove to be of value. Two or three successful cases have been reported. The author has on three occasions established an opening into the ventricular cavity through the tentorial surface of the occipital lobe, and introduced an inverted T-shaped drain of folded rubber tissue, the horizontal arm resting on the tentorium and the vertical portion passing through the opening into the ventricle. Access to the part was obtained through an omega-shaped osteoplastic flap, which was afterward replaced and tightly sutured without drainage. One patient lived six weeks with marked improvement, the head diminishing some three inches in circumference; the others died as the result of operation. Alfred S. Taylor has recently reported a series of cases resulting from epidemic cerebrospinal meningitis in which he drained the ventricles into the subdural space over the convexity, using several strands of cat-gut instead of the rubber tissue.

Cushing, in the cases in which a communication can be demonstrated to exist between the ventricles and the subarachnoid space, advises the establishment of a communication between the spinal arachnoid space and the retroperitoneal areolar tissue by means of a trephine opening through the body of the fifth lumbar vertebra and the introduction of a silver canula.

Meningocele; Encephalocele; Hydro-encephalocele.

Meningocele is a protrusion of one or more of the cerebral membranes through a congenital aperture in the skull. This usually occurs in the median line of the occipital or frontal region, the protrusion appearing as a large or small oval cystic tumor beneath the scalp which increases in size and tension on coughing or crying. Fluctuation is generally present and the contents may be diminished by pressure (Fig. 145).

Fig. 145.



Cerebral meningocele.

Encephalocele is the protrusion of a portion of brain-tissue within a meningocele.

Hydro-encephalocele is an encephalocele which contains also within the brain-substance a cavity communicating with the ventricle.

These conditions are all due to congenital defects and in most instances the tumors are present at birth. The larger and perhaps the most frequently observed instances are those belonging to the hydro-encephalocele class.

The **treatment** of these conditions is very unsatisfactory, as a rule. Extirpation of the sac, with ligature of the pedicle and closure of the wound, is to be advised in meningocele and encephalocele when the brain-substance can be reduced. The insertion of a celluloid plate, between the scalp and the surrounding bone, is to be recommended to prevent recurrence. Removal of a protruding portion of the brain-substance may be attempted. When no operative measures seem advisable the child should wear some protecting apparatus to avoid rupture from blows or falls.

Hernia Cerebri.

Hernia cerebri is protrusion of a portion of the brain through an opening in the skull. This condition is frequently observed after compound fractures and operations on the brain when marked intracranial pressure is present.

The protrusion may occur beneath the healed scar of such an injury, or it may occur before closure of the wound. In the latter case the condition is perhaps more accurately described as *prolapse* of the brain. The condition is extremely troublesome, as the protruding portion consists of a fungating bleeding mass, which may readily become infected and is a source of great annoyance to the patient.

The **treatment** should consist in attempt to cover the mass with sound skin, or, better, with a bone flap. To accomplish this, excision of the protruding mass may be necessary. The operation is a difficult one, and is attended with considerable danger. When the skin is unbroken the hernia may be treated by an external protecting plate of celluloid or metal, or such a plate may after reduction be inserted between the scalp and the bone.

Traumatic or Focal Epilepsy.

When, following a severe trauma of the head presumably associated with some injury to the brain or its membranes, a previously healthy individual becomes epileptic, the condition is spoken of as a *traumatic epilepsy*. When in a given case of epilepsy the seizure invariably begins in a certain group of muscles and always progresses in a regular order which corresponds to the areas in the motor region of the brain cortex which would be affected by an irritation spreading from a given point, the condition is called *focal* or *Jacksonian epilepsy*.

In these cases the cause of the epileptic attack is probably a local one situated at the point of injury or in that part of the motor area of the cortex which corresponds with the group of muscles first attacked by the seizure. In these cases exploratory operations are indicated, and removable lesions are frequently found which fully account for the symptoms. The lesion may be a depressed spicule of bone, an adhesion between the dura and pia, a dural, pial, or cortical hemorrhage, or a cyst resulting from such a hemorrhage, a patch of meningeal thickening, a small cortical abscess or tumor.

The **treatment** of these cases should consist in an exploratory osteoplastic resection of the skull, with relief of pressure from any cause, separation of adhesions, removal of a foreign body or solid tumor, evacuation of a cyst or cortical abscess, or in some instances complete excision of a hopelessly diseased cortical area.

The **prognosis** should be guarded, for although the original cause of the disease may be removed, the "epileptic habit" is often established, which will require a continuance of the ordinary medical treatment for some time after recovery from the operation.

It has been suggested by Jonnesco to remove the two upper cervical ganglia of the sympathetic for cure of the ordinary idiopathic epilepsy. The operation, which is described in Chapter XI., has been followed by improvement in a few cases, but the number of failures is so greatly in excess of the successes that the operation has fallen into disfavor.

Traumatic Cephalalgia.

Severe persistent headache following a cranial trauma and accurately localized on the supposed seat of injury is due, not infrequently, to some local lesion similar to those producing epileptic seizures. The probability of such an association is accentuated if pressure over the scar or seat of injury is painful and acts as an exciting cause of the headache. In these cases exploratory operation is to be advised if the symptoms are of such a character as to justify the comparatively slight risk of such a procedure.

The Cerebral Injuries of the Newborn.

The terms *infantile cerebral palsy, congenital spastic paralysis,* etc., are generally employed to indicate physical defects which are the direct result of injuries to the brain occurring during parturition. *Idiocy, imbecility*, and *epilepsy* are also not infrequently due to these injuries. In the great majority of instances the lesions in these cases are due to hemorrhages, lacerations of the meninges or of the cerebral substance, to œdema, to an increased intracranial tension, and to the frequently associated asphyxia.

The investigations of Cushing, Carmichael, and others have shown that in many, if not the majority of these cases, the primary lesions are located over the convexity of the cerebrum and near the superior longitudinal sinus.

It is obvious that if these cases can be successfully operated upon during the first few days after birth, the clots removed, and pressure relieved, many of the disastrous secondary lesions can be avoided. The subject is a new one, and comparatively little attention has been paid to it by surgeons, but the brilliant success which has been achieved by Cushing in four such instances leads to the belief that much may be accomplished by early operation in these otherwise hopeless cases.

In operating upon these cases the same methods should be employed as in adults, great care, however, being necessary in the administration of the anæsthetic and in the measures employed to maintain the body temperature and to combat shock.

Among the other causes of idiocy and imbecility some authors include premature ossification of the sutures and fontanelles, causing intracranial pressure from a failure of the skull to expand to meet the requirements of the growing brain. In these cases *linear craniectomy* has been advised. The operation consists in making one or more incisions through the skull parallel with the sagittal suture and extending from the frontal region to the occiput. Supplementary incisions are sometimes made at an oblique or right angle to these, which allow a very considerable amount of expansion of the skull. As there is little or no reason to believe that the mental defects are in any way dependent on the early closure of the sutures, the operation has little to recommend it, and has been generally abandoned by surgeons.

Tumors of the Brain.

The tumors which occur in the brain or grow from its membranes are, in the order of frequency: syphilitic or tuberculous gummata, endotheliomata, gliomata, sarcomata, angiomata, psammomata, fibromata, neuromata, and cysts.

Symptoms.—These depend entirely upon the situation of the tumor and the structures pressed upon by its growth. It not infrequently happens that tumors even of considerable size may exist for months or years in one of the silent areas of the brain without producing symptoms which lead one even to suspect intracranial disease. On the other hand, comparatively small growths in other regions may produce a train of symptoms of the most painful and distressing character, making life unbearable and driving patients to suicide. The four cardinal symptoms of brain tumor are headache, vomiting, vertigo, and optic neuritis. While all of these symptoms are usually present at some period in the history of most cerebral tumors, they are by no means always early symptoms, and are certainly not pathognomonic of new growths, for they may occur in any intracranial disease which produces ventricular distention or slowly developing pressure from other causes. These four symptoms may be called the general symptoms of tumor, and are usually present whatever its location. In addition to the changes in the optic disk, Harvey Cushing has recently called attention to another important and very early ocular sign of intracranial pressure, which is frequently the first positive indication of cerebral tumor. This sign consists in the demonstration of a change in the color fields, with irregularity and overlapping of the various color areas.

While the detection of this sign requires special ophthalmologic training, and for that reason probably it will not be very generally employed, it should nevertheless be borne in mind that it is an early and important sign.

Many other symptoms may be present, due to the location of the growth, and may be spoken of as the special or localizing symptoms, for by their presence or absence conclusions may often be drawn regarding the probable situation of the growth. Of the special symptoms which may be produced by the growth of a cerebral tumor, the most important are those caused by the irritation or paralysis of certain well-known cortical centres or the origins of the cranial nerves. Thus in tumors of the motor area we have Jacksonian epilepsy, manifested in the muscles of the face or extremities on the side of the body opposite to the lesion; or if the pressure is greater, paralysis of one or more groups of these muscles will result. In tumors of the superior parietal convolution, astereognosis is observed. In tumors of the prefrontal region there may be no localizing signs, but mental disturbances are of frequent occurrence, especially if the lesion is in the left hemisphere (Phelps). In growths affecting the posterior extremity of the third left frontal convolution motor aphasia is present. In tumors of the occipital lobe and of the posterior portion of the parietal lobe, visual disturbances are common, while in the temporosphenoidal lobe, especially on the left side, a tumor may give rise to deafness and impairment of the senses of taste and smell.

Tumors at the base of the brain may produce hemiplegia, hemianopsia, hemianæsthesia, with paralysis of one or more of the cranial nerves. Tumors of the hypophysis give rise to bitemporal hemianopsia, severe headache, symptoms of acromegaly, and loss of sexual power. Tumors of the cerebello-pontine angle, the so-called acoustic neuromata, cause a distressing tinnitus, unilateral deafness, and later, give rise to paralysis of the fifth, sixth, and seventh nerves. Tumors of the cerebellum, if near the worm, produce marked ataxia and staggering gait; the patients, when asked to walk a straight line, will more frequently stagger away from the side on which the tumor is located, than toward it. Cerebellar tumors also give rise to a rapidly advancing choked disk and nystagmus. Nerve-deafness when present may be regarded as a reliable indication of the situation of the tumor. It occurs on the same side as the lesion, while the other cranial nerve palsies occasionally present in cerebellar tumor may occur on either side. Tumors of the medulla are generally rapidly fatal, the early symptoms being cardiac and respiratory disturbances with dysphagia and cranial nerve palsies.

Of all the symptoms of cerebral tumor, the pain and vomiting are the most distressing. The pain is seldom definitely localized, but it is progressive in character, eventually becoming so severe as entirely to prevent sleep, and, with the uncontrollable vomiting, produces a condition of extreme exhaustion.

Occasionally the headache is more localized, but too much reliance should not be placed on this symptom in locating the lesion, for the reason that prefrontal growths often are accompanied by severe occipital pain, and cerebellar tumors not infrequently give rise to pain located chiefly in the frontal region.

There is little to help us in determining the nature of the growth. A well-marked history of syphilis, and the fact that the early cerebral symptoms were of a transitory nature, and varied in character, would indicate the probability of a syphilitic gumma; while a tuberculous history and the evidences of tuberculosis in other organs would favor the belief that the growth was of tuberculous nature. The occurrence of cerebral symptoms following malignant disease in other organs would suggest the probability of a metastasis of malignant character. Rapid development of symptoms and evidences of pressure would suggest a rapidly growing sarcoma rather than a more slowly developing glioma or fibroneuroma. Psammomata occur chiefly within the ventricles or the region of the lateral recesses and the flocculus. Hydatid cysts of the dura and tentorium have been reported. Cystic formations caused by blood-clots are of fairly frequent occurrence, but as they show no tendency to grow they rarely produce severe symptoms.

The **prognosis** in non-syphilitic tumors of the brain is grave. Unless relief is afforded by surgical means the termination is invariably fatal.

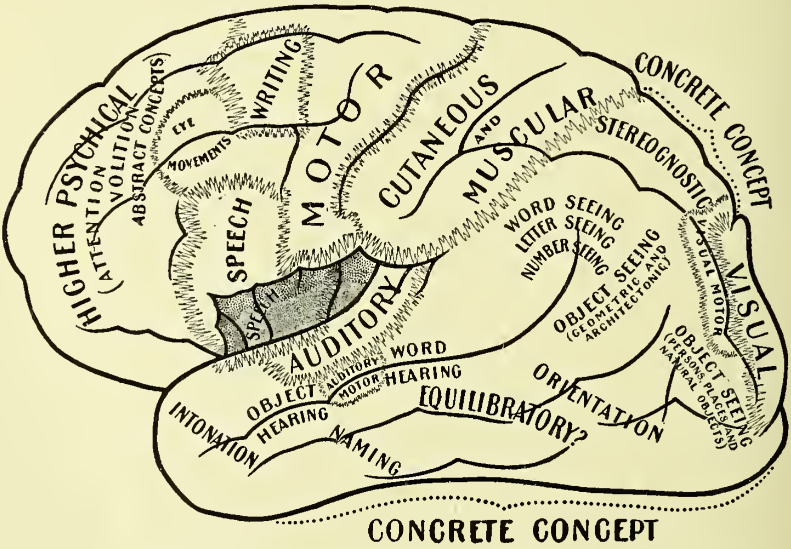
Treatment.—Syphilitic gummata of the brain should be treated by progressively increasing doses of potassium iodide combined with mercury, administered by the mouth, inunction, or hypodermic injection. The iodide should be given in large doses, as improvement frequently does not manifest itself until from 100 to 300 grains are given daily. Tumors of a doubtful nature should also receive the benefit of this treatment for purposes of diagnosis. While the vast majority of tumors of the brain are inaccessible for surgical treatment, in a few instances (about 7 per cent.) tumors are located in regions in which they may be successfully exposed and extirpated. Whenever there is a reasonable probability that a non-syphilitic tumor is located at or near the surface of the cerebrum or cerebellum the region should be exposed by an osteoplastic resection of the skull, the dura opened, and the surface of the brain examined. Absence of pulsation and an induration appreciated by palpation suggest the possibility of a subcortical growth. Solid tumors may be recognized by their appearance and density, angiomata by their pulsation and compressibility, cysts by the sense of fluctuation. Gliomata are often difficult of recognition on account of their soft consistence and the fact that when situated beneath the surface they present an appearance only of an enlarged convolution and have no sharply defined borders. Exploratory puncture of the brain by means of a director or blunt-pointed probe will occasionally reveal the presence of a tumor at some distance from the surface. Incision through the cortex and palpation of the deeper parts with the finger enabled the writer on one occasion to detect a hard cerebellar tumor situated about one inch from the surface. When located, the tumor can generally be removed by enucleation by the finger, a sharp spoon, or a flat periosteum elevator. Hemorrhage should be checked by ligation of the pial vessels and the liberal use of hydrogen peroxide in the cavity, followed by packing with sterile gauze. If no hemorrhage follows removal of the tumor, only a small rubber tissue drain should be left in the wound, the bone flap returned and sutured in place. If the wound is packed, the flap should not be sutured until the packing is removed, or a window should be cut in the bone to allow of its subsequent removal. While these procedures are accompanied by grave dangers, the risk is justifiable, for the disease if left to itself is invariably fatal.

When the tumor cannot be accurately located or when its complete extirpation is impossible, removal of a large piece of the skull with an opening in the dura will often relieve the intracranial pressure and bring about a marked amelioration in the pain, vomiting, optic neuritis, and other distressing symptoms. A favorite site for such decompression operations is, as suggested by Cushing, in the temporal region, as the resulting disturbances are less than when more important areas are crowded through the cranial defect. Whenever the opening in the skull is near the motor area, paresis or paralysis is apt to follow the operation from pressure of the cortex on the bony margin of the opening.

CEREBRAL LOCALIZATION.

While it would be manifestly impossible in a text-book of this size to discuss at length the vast subject of cerebral topography and localization, or to enter into a discussion of the anatomic data which form the basis of modern neurologic diagnosis, a general knowledge of the well-known cerebral centers and their relation to the surface of the cranium is important to all general surgeons, as well as the usual gross symptoms and signs of focal cerebral disease. A glance at Figs. 146 and 147 will give a general idea of the principal well-established centres, and a study of Plate VI., with a perusal of the syndromes for each of the seven lateral areas, will give the reader a fair impression of the symptomatology of the usual surface lesions.

Fig. 146.



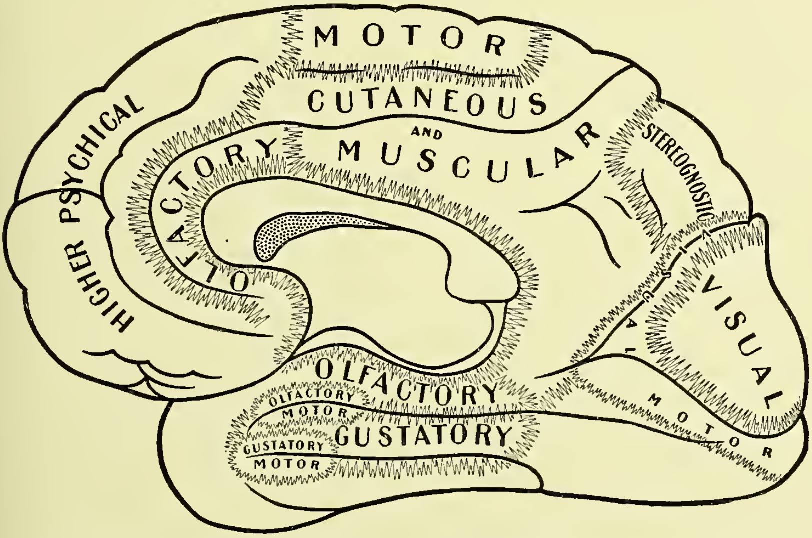
Side view of human brain, showing localization of functions. (Charles K. Mills.)

CRANIAL TOPOGRAPHY.

To guide the surgeons in opening the skull to attack lesions in certain definite locations, the relation of the chief fissures and convolutions to certain external landmarks is important. By determining the position of the fissure of Rolando, the fissure of Sylvius, and the parieto-occipital fissure, one can locate with reasonable accuracy any of the well-known cortical centres.

To locate the fissure of Rolando, measure the distance from the glabella to the external occipital protuberance, mark a point one-third of an inch behind the centre of this line, and from this point draw a line obliquely downward and forward three and a half inches in length at an angle of 67 degrees with the median line. To locate the fissure of Sylvius, draw a line from the lower margin of the orbit backward through the centre of the external auditory meatus; draw a second line parallel with this from the external angular process of the frontal bone backward for a distance of one inch and a quarter; make a mark one-quarter of an inch above this point. Next find the most prominent portion of the parietal eminence, and make a second mark three-quarters of an inch below this eminence; a line connecting these two points will lie directly over the fissure of Sylvius. To find the parieto-occipital fissure, continue the line of the fissure of Sylvius back-

FIG. 147.



View of the mesial surface of the human brain, showing localization of functions. (Charles K. Mills.)

ward until it intersects the median line. The fissure lies immediately beneath the junction of these two lines. The lower margin of the occipital lobe and the attachment of the tentorium will be indicated by a line drawn from the upper margin of the external auditory meatus to the occipital protuberance. The cerebellum lies below this line. The lateral sinus extends along this line from the occipital protuberance forward to a point one inch behind the meatus; it then passes downward toward the mastoid process.

The main trunk of the middle meningeal artery lies at a point an inch and three-quarters above the zygoma and an inch and a half behind the external angular process of the parietal bone.

Charles K. Mills, in 1902, from the facts then available regarding cerebral localization and cranial topography, published a paper giving seven lateral cranial areas for osteoplastic operations, with syndromes for each region. These areas are shown in Plate VI., and the corresponding syndromes quoted from his original article. In each case the symptoms of irritation or destruction of the region are given first, afterward those of advancing pressure.

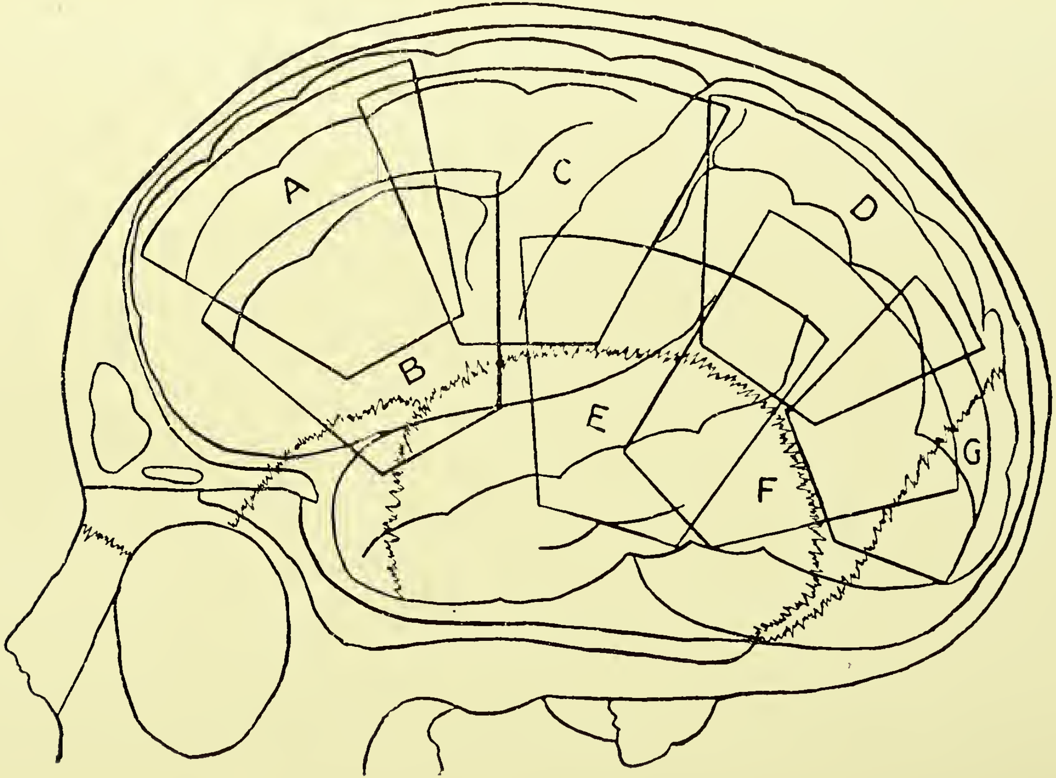
A. **Higher Psychical Area.**—Interference with higher psychical processes as shown in lack of power of sustained attention, impairment of the faculties of reason, comparison and judgment; mental obtuseness; relative optimism; sometimes mild hallucinations and delusions. Among the most likely compression and invasion symptoms are motor agraphia, motor aphasia, monoplegia or hemiplegia. On the negative side are absence of anesthesia, cutaneous or muscular; astereognosis, hemianopsia, word blindness, word deafness, and paraphasia.

B. **Motor Speech Area.**—Motor aphasia, usually associated with some motoragraphia, and paresis, especially of the face. More complete hemiplegia may indicate compression or invasion, as may also some psychical disturbance. On the negative side absence of the same symptoms as given for the Area A.

C. **Motor Area.**—Monoplegia or hemiplegia, spasms usually beginning in one limb or in one side of the face, and usually either confined or more marked in the half of the body opposite to the side of the lesion. Tonic spasticity is usually present, and both the superficial and deep reflexes are much exaggerated, persistant ankle clonus and the Babinski response being present. Motor aphasia and agraphia may be compression and invasion symptoms when the tumor spreads cephalad, or affections of cutaneous and muscular sensibility and astereognosis when it increases caudad. Psychical symptoms, except those due to general cerebral irritation, and visual and auditory symptoms are usually absent.

D. **The Stereognostic Area.**—Astereognosis and hemiataxia,

PLATE VI



Cranial Areas for Osteoplastic Operation, these areas corresponding to regions of the left hemicerebrum with definite syndromes.

impairment of muscular sensibility and of cutaneous sensibility; the superficial reflexes usually impaired; the Babinski response not present, but the normal metatarsophalangeal response often absent, that is, the toes not moving from irritation of the sole of the foot; the deep reflexes practically normal. Frequent compression and invasion symptoms are gradually augmenting hemiparesis, gradually increasing reflexes up to the point of exaggeration, and hemianopsia. Higher physical symptoms absent and aphasias usually absent; sensory aphasia present at times when the tumor spreads backward and downward.

E. **The Auditory Area.**—Word deafness, partial or complete; verbal amnesia and paraphasia. Compression and invasion symptoms may be paresis or paralysis; visual symptoms, such as word blindness and hemianopsia, and impairment of cutaneous and muscular sensibility. Reflexes usually not much altered. Higher psychical symptoms, motor agraphia, motor aphasia, and astereognosis usually absent.

F. **The Higher Visual Area.**—Word and letter blindness and verbal amnesia. Compression and invasion symptoms chiefly auditory symptoms and hemianopsia, although astereognosis, ataxia, and motor disturbances may be present. The Wernicke reaction, motor disorders, and higher psychical disturbances are usually absent; and the deep and superficial reflexes in the extremities are usually not altered. The superficial reflexes are most likely to be impaired, owing to the anesthesia.

G. **The Lower Cortical Visual Area.**—Hemianopsia often associated with forms of word blindness when the tumor is of considerable size; other localizing phenomena usually absent.[1]

OPERATIONS ON THE BRAIN.

As the special procedures which are indicated in the surgical treatment of the different brain-lesions have already been described, it remains only necessary to describe the methods of opening the skull and gaining access to the various regions of the cranial cavity.

Trephining. Craniotomy.

While the term "trephining" literally refers to the act of cutting out a circular piece of the skull with a trephine (Fig. 148), it has by common usage been employed to indicate any surgical method of opening the cranial cavity.

Before proceeding to open the skull, the patient's head should be shaved and the chief fissures and other landmarks laid out and permanently marked on the scalp by needle-scratches. After this is done the entire scalp should be carefully prepared for an aseptic operation.

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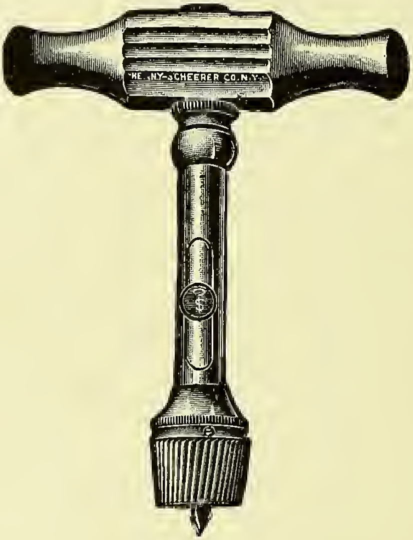
[1] For additional data in regard to cerebral localization, the reader is referred to Prof. Starr's "Organic Nervous Diseases."

After the patient is anæsthetized the region to be explored is determined and the centre of the proposed opening indicated by the mark of an awl driven through the soft parts into the bone. If the trephine is to be used, a generous curved incision should be made through the tissues of the scalp down to the bone, the soft parts retracted, and the awl-mark located. The central pin of the trephine should be placed over this mark and the trephine rotated backward and forward until a distinct groove is cut in the bone. The pin is then drawn upward and the sawing continued until the inner table is perforated at one or more points. This is indicated both by the sensation imparted to the hand and by exploration of the cut with the flat end of a probe or wooden toothpick. The button of bone can be removed by lateral manipulation of the trephine or by a narow periosteum elevator. After the button of bone is removed, the opening in the skull may be enlarged to any extent by rongeur forceps.

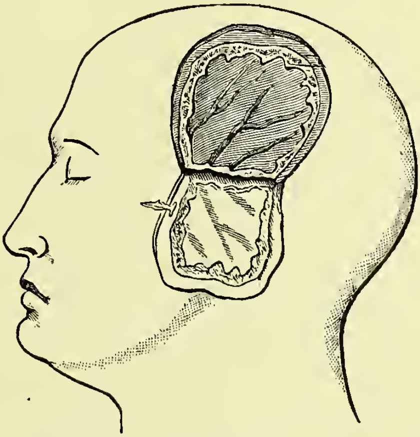
Fig. 148.



Trephine.

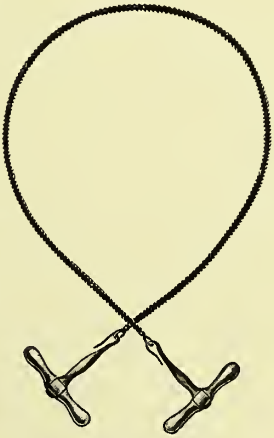
Osteoplastic Craniotomy.—When the osteoplastic method is employed, an omega-shaped incision is made, the base of which will be so situated as to contain the bloodvessels and nerves supplying the part. This incision is carried to the bone, but without retracting the soft parts any more than is necessary to expose freely the curved line of the bare bone at the bottom of the incision. The bone is next chiselled through by means of the Hartley gouges, or is divided by the Gigli saw (Fig. 150) through a series of small trephine-openings; or one of the various forms of the surgical engine may be employed. When the bone is sufficiently loosened, it is carefully raised by an elevator, the soft parts remaining attached, and is broken off at the base of the omega. As the size of the opening which may be made by this method is unlimited, large areas of cerebral cortex can be examined, and, after the necessary procedures have been carried out, the bone may be replaced, the soft parts sutured, and no defect in the skull remains. The method in skilful hands is quicker than that by the use of the trephine; it gives far greater exposure and leaves no weak spot for the subsequent development of a hernia.

Fig. 149.



Osteoplastic resection of skull, after Wagner.

Fig. 150.



Gigli saw.

After the skull has been opened by either of these methods the dura may be divided by a curved incision, which is best made by a fine pair of curved scissors. The further steps of the operation are determined by the character of the lesion, and have already been described. In closing such a wound the dura should be united with catgut, the scalp by silkworm gut, a large dressing of sterile gauze and cotton should be applied and held in place by a starch or dextrin bandage.

To expose the cerebellum, Cushing employs a T-shaped incision through the soft parts, laying bare both halves of the occipital bone. He then removes enough bone to expose thoroughly both hemispheres. By partly dislocating one lobe, he is able to retract the other sufficiently to gain access to the cerebello-pontine recess without lacerating the cortex or producing dangerous pressure on the medulla.

Cushing's temporal decompression operation consists in exposing the bone by means of a curved incision above the zygoma, separating, but not dividing, the fibres of the temporal muscle, and removing a sufficient area of bone and dura to give relief of the intracranial pressure; after which the soft parts are accurately replaced and sutured. In cases of extreme tension, the operation may be performed on both sides. For additional data on the technic of cerebral operations and for a description of the rarer procedures, as the approach to the hypophysis, etc., the reader is referred to the recent monographs of Horsley,[1] Hartley,[2] and Cushing.[3]

INJURIES AND DISEASES OF THE SPINAL CORD.

In an organ as deeply seated and as well protected as the spinal cord it is difficult to understand how it can be structurally injured by a blow or other trauma applied to the back which does not produce a fracture or dislocation of the bony canal. That such is the case, however, is evidenced by an abundance of pathologic material.

Concussion, Contusion, and Multiple Punctate Hemorrhages of the Cord.

Much controversy has arisen regarding these three conditions, the existence of which as distinct pathologic processes, unassociated with other graver lesions, and recognizable during life, is open to question. While we are not prepared to deny that distinctly spinal symptoms, as pain, numbness, more or less complete paralysis of sensation and motion, relaxation of the sphincters, etc., may be present for a short period following spinal traumata, which do not exhibit evidences of grave and more permanent lesions, and may perhaps be conveniently classed under the term *concussion of the*

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[1] "British Medical Journal," August 25, 1906.
[2] "Annals of Surgery," April, 1907.
[3] Keen's "Surgery," vol. iii.

spine, that such symptoms may persist for any considerable period of time has not been proved. These cases should be clearly differentiated from those of *traumatic neurasthenia* and *hysteria,* in which the only spinal symptoms present are purely subjective in character, and the chief disturbances are mental and emotional rather than physical.

Spinal Hemorrhage.

By spinal hemorrhage is meant a hemorrhage of sufficient extent to produce pressure-symptoms, which may occur as a result of trauma, within the bony canal of the spine.

Extradural and Subdural Hemorrhages.

Extradural and subdural hemorrhages are described in most works on surgery. They are present in practically all cases of severe injury to the spine, and by their presence and the pressure they exert may modify to a certain extent the symptoms present in such cases. If they ever occur unassociated with fracture or dislocation or without injury to the cord, they are surgically unimportant, for they cannot be recognized during life (Bailey).

Hæmatomyelia; Intramedullary Hemorrhage.

This condition, as accurately described by Bailey, is of fairly frequent occurrence. It is chiefly confined to the cervical region, and is generally caused by sudden forcible flexion or extension of the vertebral column, without fracture, such as results from diving in shallow water and striking the head violently against the bottom.

The hemorrhage occurs chiefly in the anterior horn of the gray matter, and may extend upward or downward for a considerable distance. Occasionally it spreads to both sides of the cord and involves the posterior horns.

The **symptoms** are often complete muscular paralysis below the lesion with varying sensory disturbances, of which loss of sensibility to heat and cold, and to pain, with normal tactile sensibility, are the most characteristic. Paralysis of the bladder and rectum may be present and bedsores occasionally develop.

The **prognosis** depends upon the extent of the hemorrhage. In general it may be said that in an ordinary case of hæmatomyelia partial or complete recovery may be expected within two or three months.

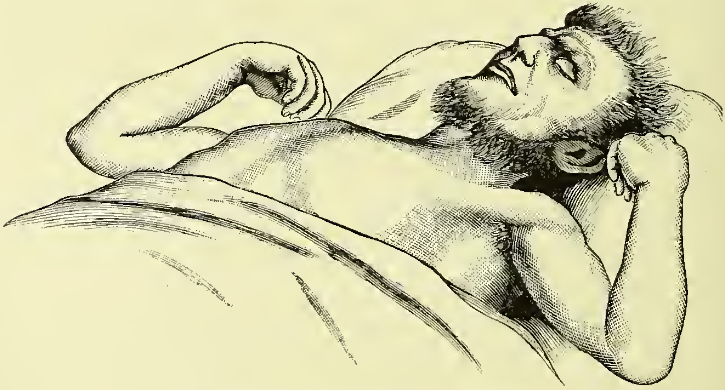
The **treatment** of spinal hemorrhage consists in rest and careful nursing, to avoid bedsores and cystitis.

Transverse, Crushing Lesions of the Cord from Fracture, Dislocation, or Direct Wound.

This is the pathologic condition commonly present in cases of "broken back." The injury is caused in these cases by the crushing force of a displaced vertebral segment, which, however, frequently springs back into place before the patient is seen by the surgeon, leaving no obvious sign of dislocation or fracture with displacement.

The **symptoms** of a transverse lesion of the cord are total paralysis of sensation and motion below the point of injury with immediate absence or diminution of reflexes (these, however, may return at a later period or become exaggerated). The muscles supplied by the injured segment atrophy and present the reaction of degeneration. The muscles supplied by the segments below the injury subsequently contract and become rigid. Transverse lesions of the cord at or above the fourth cervical segment are rapidly fatal from paralysis of the muscles of respiration. If the lesion lies below the origin of the phrenic nerves life may be somewhat prolonged. In fractures in the neighborhood of the fifth and sixth segments Thorburn describes a characteristic attitude: The patient lies with the arms abducted and rotated outward, the elbows flexed, and the forearm supinated. There is total paralysis of sensation and motion below the point of injury, with priapism, paralysis of the rectum and bladder, and the formation of bed-sores. Respiration is embarrassed and asphyxia may occur from inability of the patient to expel mucus from the trachea and bronchi. In lesions of the lower dorsal and lumbar regions the prognosis as to life is

FIG. 151.



Thorburn's position in fracture of spine.

better, death generally taking place from sepsis due to bed-sores or infection of the bladder and kidneys.

The evidence is very slight, that in a total transverse lesion the cord is ever regenerated to a sufficient extent to result in a restoration of function.

The **treatment** in cases of total transverse lesions of the cord should consist in careful nursing, to avoid bedsores and infection of the bladder. Pressure over the sacral region should be avoided by rubber rings, and the parts should be kept scrupulously clean. The position of the patient should be frequently changed, and all pressure-points frequently bathed with alcohol. Regular aseptic catheterization is necessary. The application of a plaster jacket is advisable to keep the parts at rest.

Incomplete Crushing Lesions of the Cord.

These may occur in fractures of the vertebral arches and in partial luxations. The symptoms are incomplete paralysis of sensation and motion, the distribution of the anæsthesia being asymmetric. In these cases, which are rare, exploratory operations are indicated for the detection and removal of depressed fragments of bone and to relieve pressure on the cord.

Injuries to the Cauda Equina.

Below the first lumbar vertebra fractures of the spine injure only the cauda equina, and while sensory and motor paralysis, absence of reflexes and trophic disturbances follow these injuries and closely simulate injuries of the cord, several points of difference may be enumerated.

Cord injuries, as a rule, are not associatod with pain. Injuries of the cauda give rise often to severe pain, especially in the hyperæsthetic zone just above the paralyzed area. In injuries of the cauda the anæsthesia is irregular in distribution, and generally less in extent than in cord lesions. The cauda, being made up of peripheral nerves, is capable of repair after injury, and for that reason recovery more frequently occurs than after crushing injuries of the cord.

The tissues of the cauda are more resistant to injury than the cord; a given trauma will, therefore, produce more complete destruction of the latter than of the former structure.

In spinal injuries above the second lumbar vertebra both cord and cauda may be injured, evidenced by the occurrence of sensory disturbances one or two segments above the level of the cord injury. In these cases evidence of severe injury to the nerve roots renders the prognosis more grave, as it is probable that the injuring force was sufficiently severe to produce a crushing lesion of the cord.

Operative Treatment of Spinal Injuries.

As sufficient regeneration to insure a return of function never occurs after complete transverse crushing lesions of the cord, operation is of no value.

As the symptoms of hæmatomyelia frequently disappear spontaneously, and as the lesion cannot be influenced by operative intervention, operation is distinctly contraindicated. This leaves only the incomplete injuries of the cord and the lesions of the cauda equina, which are likely to be benefitted by operation.

If, therefore, an accurate diagnosis could be arrived at in all cases at the time of injury, the operative indications would be clear. Unfortunately, however, this is not the case, as Mixter, Munro, and others have reported cases recovering after operation when the symptoms clearly pointed to a crushing lesion of the cord.

Most surgeons now agree with Walton, McCosh, and Keen, who advocate an exploratory laminectomy after a reasonable period of observation in all cases of doubt regarding the character and extent of a given cord injury.

Spinal Tumors.

Tumors causing pressure on the spinal cord may grow from the bony spine, from the spinal membranes, or from the cord itself. Tumors of the bone are generally malignant in character and are most frequently secondary to deposits elsewhere. Exostoses and chondromata have been reported. Of the meningeal tumors, which form the most important class, sarcomata and endotheliomata are the most common, while myxomata, fibromata, lipomata, and psammomata are occasionally encountered.

Sarcomata and gliomata occur in the cord, but are, as a rule, inoperable.

Of the infective granulomata, tuberculous and syphilitic gummata are of frequent occurrence, especially the former. These may produce the same symptoms as the genuine new growths. The majority of meningeal tumors develop on the posterior or lateral aspect of the cord, which accounts for the early occurrence of sensory disturbances.

Symptoms.—These, as a rule, are classified as *root symptoms* and *pressure signs*. Irritation of the sensory nerve-roots by a growing tumor gives rise to neuralgic pains, increased by motion; various paræsthesias, and later anesthesia. These may persist for months or years before motor symptoms occur. At a later period there occur muscular spasms, paresis, and finally paralysis, with the reaction of degeneration and atrophy.

As a rule, the pain diminishes with the advent of the motor paralysis, and in the later stages may be absent. The reflexes at first are exaggerated, later diminished, and finally lost. Trophic disturbances occur, and the patient finally becomes bed-ridden and helpless.

In the early stages the symptoms may be unilateral; later, as the cord is more completely compressed, a total paraplegia develops.

Regarding the situation of the lesion in the spinal canal, the most reliable data can be obtained from the early symptoms of sensory root irritation. These, with the later distribution of the cutaneous anesthesia and the upper limit of the motor paralysis, will generally enable one to determine the segment of cord involved.[1]

Prognosis.—Unlike the behavior of sarcomata in other parts of the body, meningeal sarcomata grow slowly, do not infiltrate the surrounding tissues, and rarely recur, if removed at a comparatively early stage. For this reason the prognosis in meningeal tumors is favorable if the diagnosis can be made and the growth removed before the cord has been compressed to such a degree as to destroy the conductivity of its fibres. Infiltrating tumors of the cord are obviously beyond the possibility of surgical relief.

Spinal tumors unless relieved by surgical measures, in the great majority of instances, end fatally.

Treatment.—The treatment in all but the secondary or late malignant cases should be early exploratory laminectomy and removal when this is possible. In inoperable sarcoma of any of these structures the use of Coley's fluid should be tried.

Spina Bifida.

Spina bifida is a congenital defect in the spinal column caused by a non-union of the laminæ of one or more vertebral segments, usually in the lumbar or sacral regions. Several varieties exist:

Spina bifida occulta, in which the spinal defect exists alone. The region of the defect is apt to be covered with hair. It is often associated with perforating ulcer of the foot.

Meningocele.—A hernia of the spinal membrane forming a cystic protrusion covered with epidermis.

Meningomyelocele.—A meningocele having the flattened spinal cord on its posterior wall, the commonest variety.

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[1] For a more detailed description of the facts in spinal localization, the reader is referred to the tables and plates in Starr's "Organic Nervous Diseases."

Syringomyelocele.—The meninges are defective; the protruding cyst is composed of the tissues of the cord dilated by a collection of fluid in the closed central canal. Very rare.

Myelocele.—An imperfect union of the medullary folds. The central canal is open and the medullary folds are spread out on either side and continuous with the skin. The medullary portion is of a bright-red color and highly vascular. Children with myelocele die a few days after birth from constant leakage of the cerebrospinal fluid.

Moore, who collected statistics from the literature of the operative cases prior to 1905, states that 23 per cent. occurred in the sacral region, 34 per cent. in the lumbar, 29 per cent. at the lumbosacral junction, and 14 per cent. in the cervical and dorsal regions.

The condition is often associated with other congenital defects, as club-foot and hydrocephalus; and in a fair proportion of the cases more or less paralysis of the sphincters and lower extremities is present.

Prognosis.—The prognosis of this condition, if left to itself, is grave, the severer types dying shortly after birth, and many of the cases of meningocele and meningomyelocele dying from rupture of the sac and the subsequent development of meningitis.

Treatment.—Spina bifida occulta, if well covered by healthy skin, needs no treatment. Small meningoceles without symptoms may be treated by a protective dressing to guard against rupture.

The presence of hydrocephalus, extensive paralysis, or other marked deformities would be a contraindication to operative treatment.

Meningoceles and meningomyeloceles without paralysis should be treated by operation. The sac should be exposed by an elliptical incision and freely opened. Any nerve-fibres which do not end in the sac should be dissected out and returned to the spinal canal.

The redundant sac should then be excised to a point near the neck, and the dura firmly closed by ligating the neck or by two or more rows of catgut sutures. Lovett then recommends the formation of two rectangular flaps of muscle and fascia with their bases toward the median line. These are inverted and firmly united over the stump of the meningocele by chromic gut sutures, after which the skin is united with silk or silkworm gut.

The operative mortality is about 33 per cent., and the secondary mortality after one or more years about 30 per cent. Permanent recovery may be expected in about one-third of the cases.

OPERATIONS ON THE SPINE.

Lumbar Puncture.

Lumbar puncture is practised for the relief of intracranial pressure or for purposes of diagnosis. Locate the spinous process of the fourth lumbar vertebra, and after thorough aseptic preparation of the part introduce an aspirating-needle at a point half an inch to the left of the spine and carry it obliquely upward and inward between the laminæ until the dura is punctured. This will be indicated by a flow of cerebrospinal fluid through the trocar. After sufficient fluid is withdrawn, remove the needle and close the wound with collodion or sterile zinc oxide plaster.

Laminectomy.

Laminectomy, or opening the spinal canal, is performed for exploratory purposes in fractures, dislocations, and other injuries; and for the removal of tumors.

Place the patient face downward on the operating-table, and after thorough preparation of the operative field make an eight-inch vertical incision in the median line over the spines. Divide the soft parts down to the laminæ on either side of the spinous processes and retract the edges of the incision. Control the hemorrhage by gauze pressure. Next remove the spines by heavy bone-forceps, and with small curved bone-forceps divide the laminæ on either side as near the transverse processes as possible, and remove the intervening part of the arch. Several laminæ should, if necessary, be removed to give a satisfactory exposure of the cord. If it is necessary to open the dura, it should be incised in the median line and subsequently closed with a continuous catgut suture.

Closure of a laminectomy wound should be effected with deeply placed silk-worm gut sutures, a rubber tissue drain being left in the inferior angle of the wound. After an aseptic dressing is placed over the wound a plaster-of-Paris corset should be applied and the patient placed on his back in bed.

CHAPTER XV.

INJURIES AND DISEASES OF THE HEAD, FACE, AND NECK, ORAL, NASAL, AND PHARYNGEAL CAVITIES.

Contusions.

Contusions of the scalp are of frequent occurrence. They are, as a rule, unimportant unless accompanied by subcutaneous rupture of a vessel, when a hæmatoma may result.

Hæmatoma of the scalp may occur between the skin and aponeurosis of the occipitofrontalis muscle or beneath that muscle. In the former instance there is usually an oval fluctuating swelling surrounded by an indurated ring of coagulated fibrin. As the centre of the mass is soft and apparently depressed, the condition is often mistaken for a depressed fracture of the skull. It is, however, readily distinguished from that condition by the fact that the ring lies above the surrounding bone and may be indented by pressure. In the subaponeurotic variety the blood may separate the muscle from the bone over a large area, giving rise to a diffuse fluctuating tumor which may overhang the eyebrows and present a bulging in the region of the occiput.

Treatment.—Hæmatomata may require incision and removal of the clots and fluid blood, with subsequent drainage. None of the other scalp contusions require any treatment other than rest and cooling applications.

Contusions of the face are of frequent occurrence, and often produce great disfigurement from the ecchymosis and œdema, of which the ordinary "black eye" is the type. Cold applications are usually all that is necessary in the way of treatment.

Contusions of the neck occasionally result in serious injury of the nerve-trunks, especially the brachial plexus, giving rise to a more or less complete paralysis of the upper extremity. Blows on the neck and angle of the jaw give rise to a severe degree of shock and sometimes to intracranial hemorrhage.

Wounds.

Wounds of the scalp are generally caused by falls or blows upon the head. The wounds produced are frequently clean-cut incisions resembling those made by a cutting instrument. Bleeding is apt to be profuse because of the great vascularity of the tissues. Scalp wounds heal readily even if there is considerable laceration and if a portion of the detached scalp is joined only by a narrow pedicle. Great care should be exercised in the disinfection of these wounds, especially if the subaponeurotic space is opened, as suppuration in this region spreads rapidly, is often accompanied by symptoms of grave sepsis, and the inflammatory process may be carried by the emissary veins to the intracranial structures.

Scalp wounds should be thoroughly exposed by shaving a sufficient area, carefully disinfected, and united with sutures of silk or silk-worm gut.

In wounds of the face great care should be taken to avoid subsequent deformity. Marginal necrosis should be prevented by avoiding too much tension of the sutures. If the edges of the wound are widely separated, one or two retention sutures should be passed at some distance from the edges of the cut and the margins in this way brought together. The skin should be carefully approximated and united by a number of fine silk sutures, which should be removed as early as possible to prevent scarring. If in wounds of the face branches of the seventh nerve are divided, the ends should be united with fine catgut.

If *Stenson's duct* is cut, the ends should be carefully united with catgut, or the proximal extremity should be drawn outward, passed through an incision in the mucous membrane of the cheek and secured by fine silk sutures, and the external wound closed. In case a fistula results, this may often be cured by wearing a soft probe in the duct introduced through the oral orifice and carried beyond the fistula to the gland, the outer portion of the probe to be curved about the angle of the mouth and secured to the cheek by adhesive plaster. In old cases in which the distal portion of the duct is obliterated a new one may be made by piercing the cheek with a trocar from the fistulous opening inward and forward to a point near the original termination of the duct. This may be kept open by a seton or the probe introduced as above. Freshening and union of the cutaneous wound by sutures or contractile collodion, while the probe is in place, may be required.

Superficial wounds of the neck differ in no way from cutaneous wounds elsewhere. They should be thoroughly disinfected and sutured. In more extensive wounds penetrating the deep fascia, important structures may be wounded, requiring special treatment. In wounds of the larger vessels the hemorrhage may be temporarily controlled by pressure, but an immediate operation should be undertaken to expose the vessels thoroughly, which should be securely ligated above and below the point of division, after which the wound should be carefully disinfected and closed with sutures.

Wounds of the pharynx, larynx, or trachea, often seen after attempts at suicide by "cutting the throat," are dangerous not so much on account of the immediate injury as by their remote results. Thus in transverse wounds above the hyoid bone the severed tongue or epiglottis may drop backward into the rima glottidis and cause suffocation; in wounds below the hyoid or those severing the thyroid cartilages an œdema of the glottis may suddenly appear and cause death from suffocation before help can arrive; while in wounds of the trachea the blood issuing from the neighboring veins or injured thyroid gland may be aspirated and asphyxiate the patient. In all of these cases death from pneumonia may occur at a later period from the inhalation of septic material. The treatment of these cases should consist in arresting all hemorrhage, carefully uniting the divided structures, and performing a tracheotomy below the injured area. In wounds involving the œsophagus the walls of this passage should be closed tightly with two layers of suture and the superficial parts brought together with provision for adequate drainage.

Wounds of the anterior portion of the neck rarely cause injury to the large nerve-trunks (pneumogastric, sympathetic, glossopharyngeal, and phrenic), on account of the deep and protected situation of these structures. Wounds in the lateral portions of the neck, however, frequently cause injury to one or more branches of the brachial plexus. Whenever a nerve-trunk is known to have been divided, the ends should be secured and united by suture.

INFLAMMATORY DISEASES.

Facial Erysipelas.

An acute, rapidly spreading inflammation of the skin and subcutaneous tissue, caused by infection with Streptococcus erysipelatis, and accompanied by high fever, rapid pulse, and other evidences of septic intoxication. The local appearances are diffuse redness and œdema of the skin, with sharply defined and slightly raised borders. Infection always takes place through some wound or break in the skin, although the point of infection may be so minute as to escape detection. From this point it spreads rapidly, and may eventually cover the entire body. When the disease involves the subcutaneous cellular tissue the symptoms are more severe, a boggy induration occurs, followed by extensive suppuration and often by fatal sepsis.

Erysipelas of the face generally begins on the bridge of the nose and extends on either side to the cheeks. When limited to these regions it may present only a butterfly-shaped area of redness without fever or general symptoms of any kind. In other cases more or less well-marked constitutional symptoms may be present, as fever, chilly sensations, anorexia, headache, vomiting, and general prostration. If, however, the disease spreads to the eyelids and scalp, œdema occurs, closing the eyes and causing considerable disfigurement. In erysipelas of the scalp the œdema is not so marked, but the constitutional symptoms are more severe. Occasionally the infection is carried by the emissary veins to the intracranial structures, producing a rapidly fatal meningitis.

Erysipelas of the neck, if confined to the skin, presents no special features worthy of mention.

The **treatment** of the superficial forms of erysipelas is rather unsatisfactory, as no method can be relied upon to stop the spread of the disease or diminish the toxæmia. Small patches occurring on the face may sometimes be aborted by painting with contractile collodion, or the application of lead-and-opium wash. In other locations the use of a wet dressing of carbolic acid (1 : 200), aluminium acetate, lead-and-opium wash, or an ointment of ichthyol (10 to 50 per cent.), will be found serviceable.

Cellulitis.

Cellulitis is an inflammation of the superficial or deep cellular tissues, due to infection by streptococci, staphylococci, or other pyogenic micro-organisms. In the scalp, infection of the superficial cellular plane, between the skin and the aponeurosis of the occipitofrontalis muscle, gives rise generally to a more or less localized abscess. If the infection occurs in the loose cellular plane between the aponeurosis and the skull, the inflammation spreads more rapidly, and a large collection of pus results which may separate the muscle from the bone over its entire extent. In these cases the pus collects in the most dependent portions of the space, producing oval bulging masses over the orbits and along the curved line of the occipital bone. In certain cases of cellulitis of the face, thrombosis of the supraorbital vein may extend to the cavernous sinus, producing exophthalmos, œdema of the conjunctiva, and grave intracranial complications.

In the neck the superficial variety differs in no respect from cellulitis elsewhere, the diagnosis and treatment of which have been considered in Chapter IX. When, however, the cellular tissue beneath the deep cervical fascia is invaded, which usually results from a suppurating lymph-node, the disease is more serious. There will be at first pain and stiffness of the neck, with œdema and a feeling of deep-seated induration and bogginess. The entire lateral region of the neck will appear swollen, but redness of the skin is rare. Chills, fever, sweats, and prostration occur early. The pus may burrow along the cellular planes and eventually reach the mediastinum. Septic thrombosis of the veins may occur and eventually lead to pyæmia and death from exhaustion.

The **treatment** of cellulitis should consist in early incision and drainage. The incisions should be free and sufficiently numerous to insure adequate drainage for every pocket of pus.

In the subaponeurotic cellulitis of the scalp care should be taken in making the incisions to avoid the bloodvessels and nerves. It may be necessary to shave the scalp. In deep cervical cellulitis the incisions should be made over or just behind the sternomastoid muscle down to the deep fascia. A grooved director should then be thrust through the muscle or fascia. When pus is reached, the opening should be enlarged by a sinus-dilator or pair of dressing-forceps introduced closed and withdrawn open. The cavity should then be explored by the finger or some blunt instrument, and another incision made over the most dependent portion of the abscess. Rubber drainage-tubes should be introduced and a wet dressing applied. If the pus has burrowed into the mediastinum, drainage should be favored by raising the foot of the bed and lowering the head, or it may be necessary to trephine the sternum.

Angina Ludovici.

Angina Ludovici is a gangrenous inflammation of the deep cellular tissue of the submaxillary region. This cellular tissue surrounds the submaxillary gland and is inclosed within a fascial and muscular recess which occupies the greater part of the digastric triangle. In this areolar tissue there are imbedded a number of lymph-nodes, some of which lie in contact with the capsule of the gland. The disease generally arises by a lymphatic infection from a carious tooth or some other septic focus in the mouth, or rarely from a septic inflammation of the submaxillary gland. The disease is always serious. In virulent cases the inflammation develops with great rapidity, causing gangrene of the areolar tissue and neighboring structures, with a rapidly developing sepsis which may cause death in from five to ten days.

The **symptoms** are at first often those of an acute infectious disease: chills, fever, thirst, anorexia, and a rapid, full pulse. Pain is not always an early symptom, but occurs later, and is often severe and throbbing in character. A painful swelling appears under the jaw, sharply limited by the attachments of the fascia. The tongue is raised and the floor of the mouth is pushed upward.

Sudden death from suffocation is frequently caused by œdema of the glottis.

Treatment should be undertaden at the earliest possible moment, and should consist in free incisions, removal of the submaxillary gland and gangrenous débris, thorough disinfection of the cavity, and packing with sterile gauze.

Inflammation and Abscess of the Parotid Gland.

Inflammation and abscess of the parotid gland may occur from pressure in drawing the jaw forward during anæsthesia, from wounds, from an ascending inflammation of the duct, or from infection of one of the lymph-nodes imbedded in its substance. It is more frequently, however, the result of some general septic disease, as typhoid fever, scarlet fever, or pyæmia. The disease generally begins as a circumscribed or diffuse indurated swelling of the gland, with pain, fever, and general malaise. The pain is increased by taking food, and stiffness of the temporomaxillary articulation may be present. After several days the mass softens and fluctuation appears.

The **treatment** is early incision and drainage. Care should be taken in making the incision to avoid wounding the external carotid artery or the branches of the facial nerve.

Carbuncle.

This disease, the nature of which has been described on page 175, may occur on any portion of the skin of the face and neck. The most common situation is on the back of the neck, near the margin of the hair. It begins as an indolent induration, spreading generally from small superficial lesions, as an infected hair-follicle or pimple. The swelling is at first painless but tender to the touch; later it may be the seat of throbbing pain, heat, and redness. There are stiffness of the neighboring muscles and general malaise. The temperature is but slightly elevated, and the patient often keeps about, using domestic remedies and regarding the condition as simply a "blind boil," until a large area of tissue is involved. Superficial suppuration occurs at a number of points which slough and gradually coalesce, forming eventually a gangrenous ulcer. Symptoms of grave sepsis appear and the patient rapidly loses flesh and strength, and if unrelieved may die of exhaustion.

The best **treatment** is by total excision of the gangrenous area with subsequent wet dressings and, if necessary, skin-grafting.

When this is impracticable, crucial incisions should be made through the indurated mass, and separation of the sloughs subsequently favored by wet dressings or poultices.

The condition is a serious one, especially in the aged and in those debilitated from diabetes and other exhausting diseases. A rare but particularly fatal form of carbuncle occasionally is encountered on the upper lip, which in malignancy is second only to anthrax.

Anthrax, or Malignant Pustule.

Anthrax is an extremely rare disease in this country. When it occurs on the face it begins by a small elevated papule surrounded by numerous vesicles, which in turn are soon surrounded by a hard, brawny induration involving all the tissues of the lip or cheek. The vesicle soon ruptures and is covered by a dark-brown or black scab. Later the entire area becomes discolored, œdema of the surrounding tissues develops, and symptoms of grave sepsis appear. In doubtful cases the diagnosis is established by finding *Bacillus anthracis* in the fluid of the vesicles. Unless a mixed infection occurs, there is an absence of pus and pain.

The **treatment** should consist in early and complete excision of the diseased area and the neighboring lymphatics, followed by wet formalin or bichloride dressings.

TUMORS.

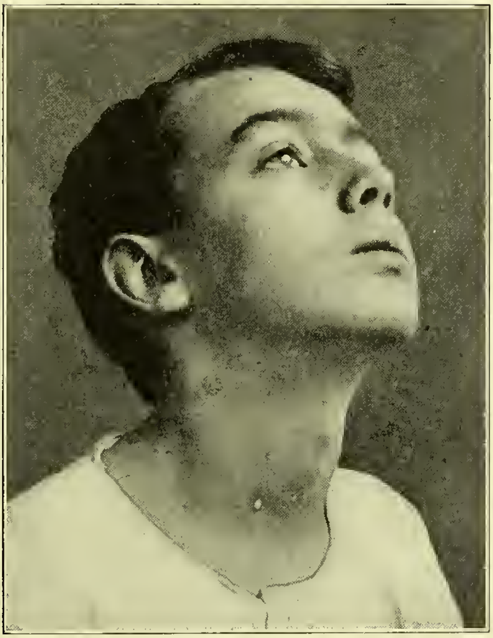
A large variety of tumors occur in the tissues of the head, face, and neck, many of which present special features.

Sebaceous Cysts.—These occur with great frequency on the scalp, rarely on the face, occasionally on the neck. They appear as rounded, freely movable bodies in the substance of the skin, varying in size from that of a small pea to that of an English walnut, or even larger. They are easily ruptured and occasionally suppurate. If the capsule is opened, the contents rapidly decompose, giving rise to a foul-smelling fungating ulcer. They are easily removed by dividing the overlying skin down to the capsule and enucleating by means of a probe, director, or other blunt instrument. If the sac ruptures during these procedures, it must be completely dissected out, as recurrence is apt to take place if any of the secreting membrane remains.

Sebaceous Adenomata.—A rare variety of sebaceous tumors, occurring on the scalp, composed of lobules of glandular tissue. They resemble the sebaceous cysts and are prone to ulcerate.

Dermoids.—These occur along the median line of the scalp or over the situation of any of the embryonic fissures; hence they are apt to be found at the outer or inner angle of the orbit, over the bridge of the nose, in the nasofacial groove, in the median line of the lip or chin, to the outer side of the angle of the mouth, about the ear, in the median line of the neck, or along the anterior margin of the sternomastoid muscle at points corresponding with the branchial clefts. These tumors may appear as small, rounded, soft, semifluctuating masses resembling sebaceous cysts. They differ from the latter, however, by having, as a rule, deep connections. Those occurring in the scalp are occasionally lodged in depressions of the bone, and may be attached to the dura mater by means of a fibrous pedicle. Those occurring in the remnants of the branchial clefts are often intimately connected with the sheaths of the great vessels of the neck. These cysts generally contain sebaceous matter and hairs; rarely, teeth and other cutaneous appendages are present. Occasionally cysts at the root of the nose and about the orbit are translucent and contain a substance resembling clear olive oil, while the deep-seated branchial cysts may contain a mucoid material. The growth of these tumors is painless; they produce symptoms only when they press upon other

FIG. 152.



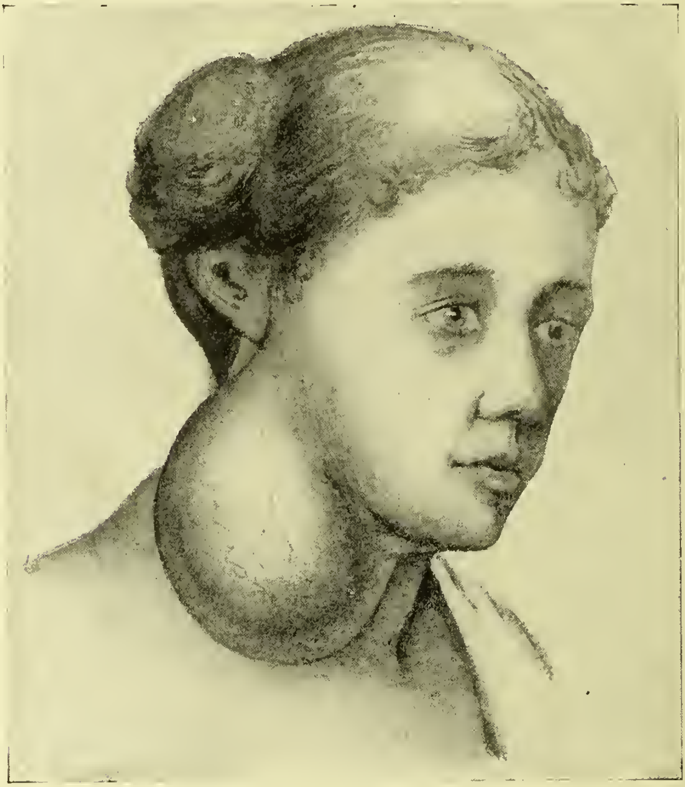
Branchial fistula.

structures. Epitheliomatous changes sometimes occur in dermoids, especially the branchial variety.

Dermoids are, as a rule, easily enucleated, and early removal is to be advised to avoid large and disfiguring scars.

Mandibular tubercles or recesses, small auricular sinuses or pedunculated tumors in front of the tragus, branchial fistulæ, colobomata, and the **various forms of harelip,** are all due to imperfect closure or other abnormalities in the union of the various embryonic fissures. Of these conditions, only the branchial fistulæ and the various forms of harelip are of surgical importance.

Fig. 153.

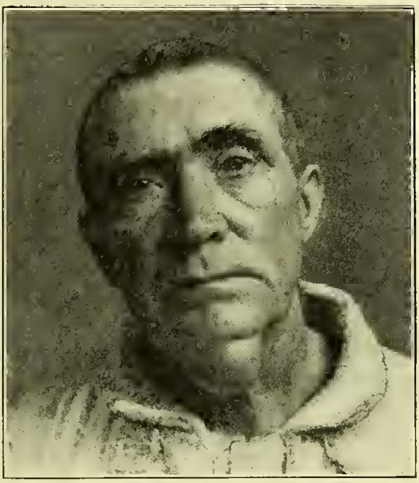


Branchial cyst. (Warren and Gould.)

Branchial fistulæ may occur at any point along the anterior border of the sternomastoid muscle, or even in the median line (Fig. 152). They are all due, according to Jordan, to a failure of complete closure of the second branchial cleft. The internal opening is always in the neighborhood of the tonsil. In the lower portion of the neck the fistulous tract lies in front of the sternohyoid and sternothyroid muscles. At a higher point it is deeply seated, lying behind the digastric muscle between the external and internal carotid arteries. The only satisfactory treatment is by complete removal—an extremely difficult and often dangerous dissection.

Branchial cysts are comparatively rare. They may occur high up beneath the angle of the jaw or at any point along the anterior border of the sternomastoid muscle. Occasionally they reach an enormous size and produce great disfigurement (Fig. 153). Epitheliomatous degeneration of a branchial cyst may occur, and, as a rule, these cases are exceedingly malignant. Up to 1904 no cure by operation had been reported.

Fig. 154.



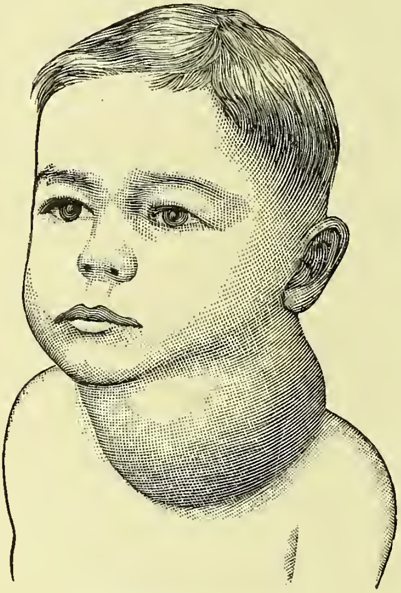
Thyroglossal cyst.

Harelip will be considered on page 329.

Thyroglossal Cysts or Fistulæ.—The thyroglossal duct is an embryonic canal leading from the foramen cæcum of the tongue downward between the two geniohyoglossus muscles, behind or through the body of the hyoid bone in front of the thyrohyoid membrane and thyroid cartilage, to the isthmus of the thyroid gland. A failure of this canal to become obliterated may result in a blind lingual or cervical fistula or the formation of a cyst, either above or below the hyoid bone (Fig. 154). If above the hyoid, the cyst may occupy the body of the tongue or the floor of the mouth (lingual dermoid). Such a tumor may grow to an enormous size, causing the tongue to protrude and seriously interfere with deglutition. Cysts occurring below the hyoid are more superficial, and generally rupture at an early period or suppurate, leaving a median sinus which secretes a small amount of mucus. Lingual dermoids, if small, may be removed by a median external incision just below the symphysis, or by a semilunar incision across the floor of the mouth. If too large to be removed through the mouth, the cyst should be evacuated or the lower jaw may be divided in the median line. Median cervical fistulæ should be dissected out up to the body of the hyoid.

Hygromata of the neck are large cystic tumors occupying the lateral regions of the neck, often growing to enormous size and giving rise to great deformity. These tumors are thin-walled, single or multiple cysts, and represent enormously dilated lymph-spaces. They are often congenital, and are rarely seen in adults for the reason that they are frequently ruptured in childhood and as a result undergo spontaneous cure (Fig. 155). They are frequently spoken of as "hydroceles of the neck," a name which is also applied to the mucous or deep variety of branchial cysts. Complete removal of these cysts is difficult and often impossible, owing to their delicate walls, which easily rupture. Incision and drainage, injections of iodine and other irritating fluids, and partial removal frequently result in a cure.

Fig. 155.



Cystic hygroma of the neck.

Lipomata are rare on the scalp or face, are occasionally found in the temporal region, and are comparatively common in the subcutaneous and deeper tissues of the neck (Fig. 156). They appear as soft, semifluctuating bodies which grow slowly and give rise to no discomfort. They are usually lobulated and rarely form adhesions to surrounding structures. Subaponeurotic lipomata of the scalp have no cutaneous adhesions, often are not lobulated, and are not infrequently mistaken for sebaceous cysts or dermoids. Small lipomata require no treatment; larger ones should be removed.

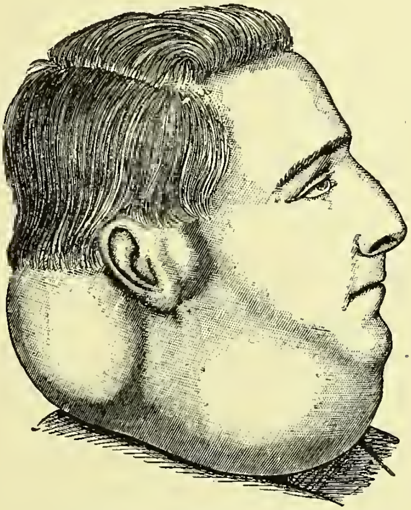
Fibromata, fibroneuromata, angiomata, hemorrhagic and bursal cysts, aneurisms of the various arteries, and other innocent tumors present no special features when they occur in these regions; their general features have already been considered.

Epitheliomata.—Squamous epitheliomata and the small basal cell variety occur on the face, the former generally at the mucocutaneous junction, the latter on the skin of the cheek, generally in the neighborhood of the orbit. Excluding the lower lip, squamous epithelioma occurs most frequently on the nose, cheeks, and eyelids; very rarely on the upper lip or chin. The disease grows slowly at first, but at a later period advances more rapidly and involves the submaxillary and cervical lymphatics.

In the small basal cell growths there is rarely involvement of the lymphatics and visceral metastasis never occurs.

Treatment.—The treatment of the squamous variety should be by wide excision, often necessitating plastic repair and extirpation of the anatomically related lymph-nodes. In the small cell variety only local removal is necessary, or the employment of radium or the *x*-rays.

Fig. 156



Diffuse lipomata of the neck.

Epithelioma of the Lip.—This is the most important and most frequently observed type of malignant growth of the face. In the great majority of cases it occurs on the lower lip in men past middle life. It may begin as a small wart-like nodule, as a superficial erosion, or as a fissure. At first the growth may be exceedingly slow, but at a later period it extends more rapidly, infiltrates the deeper structures, and involves the neighboring lymphatics. (See frontispiece.) In neglected cases the disease invades the jaw bone, and the lymphatic extension gives rise to large infiltrating tumors of the neck, which finally ulcerate and cause great disfigurement.

Treatment.—The treatment of cancer of the lip, to be successful, must be undertaken in the early stage of the disease, as late operations favor rapid extension and visceral metastasis.

When the growth is small and superficial, it may be removed by a V-shaped incision and removal of the contents of the submaxillary triangle on the side of the lesion. If located in the median line both submaxillary regions should be explored and all diseased lymphatics removed. When the disease is more advanced the entire lower lip should be excised, and the lymphatic dissection should include also the upper jugular nodes. The defect left after removal of the lip should be repaired by some form of plastic operation.

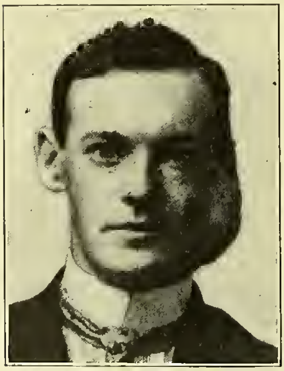
Sarcomata.—As in other portions of the body, sarcoma here may develop in any tissue of mesoblastic origin. Sarcoma of the eyeball occurs in two forms, the retinal sarcoma or glioma of children, and the melanotic sarcoma of adults which arises from the uveal tract. Two clinical varieties occur in the tissues of the neck, those arising from the fasciæ and those arising from the lymph-nodes. The latter may be primary or secondary to sarcomata of the salivary glands or tissues of the nasal or oral cavities.

The **treatment** of all of these varieties has already been considered.

Tumors of the Salivary Glands.—*Carcinoma* occurs frequently in the parotid in individuals past middle life, causing a rapidly growing tumor which infiltrates the surrounding tissues and early gives rise to lymphatic metastases. It is rarer in the submaxillary and sublingual glands.

Endothelioma may occur in any one of the salivary glands, and at any period of life, although the disease is rare in childhood and old age. In the parotid the growth may be rapid or slow. The slowly growing endotheliomata are generally composed of glandular masses, myxomatous cysts, cartilage, and fibrous tissue—the so-called *mixed tumors of the parotid* (Fig. 157). They are innocent or feebly malignant. In the submaxillary and sublingual glands the disease resembles carcinoma, is more rapid, and sometimes exceedingly malignant (Plate VII.).

Fig. 157.

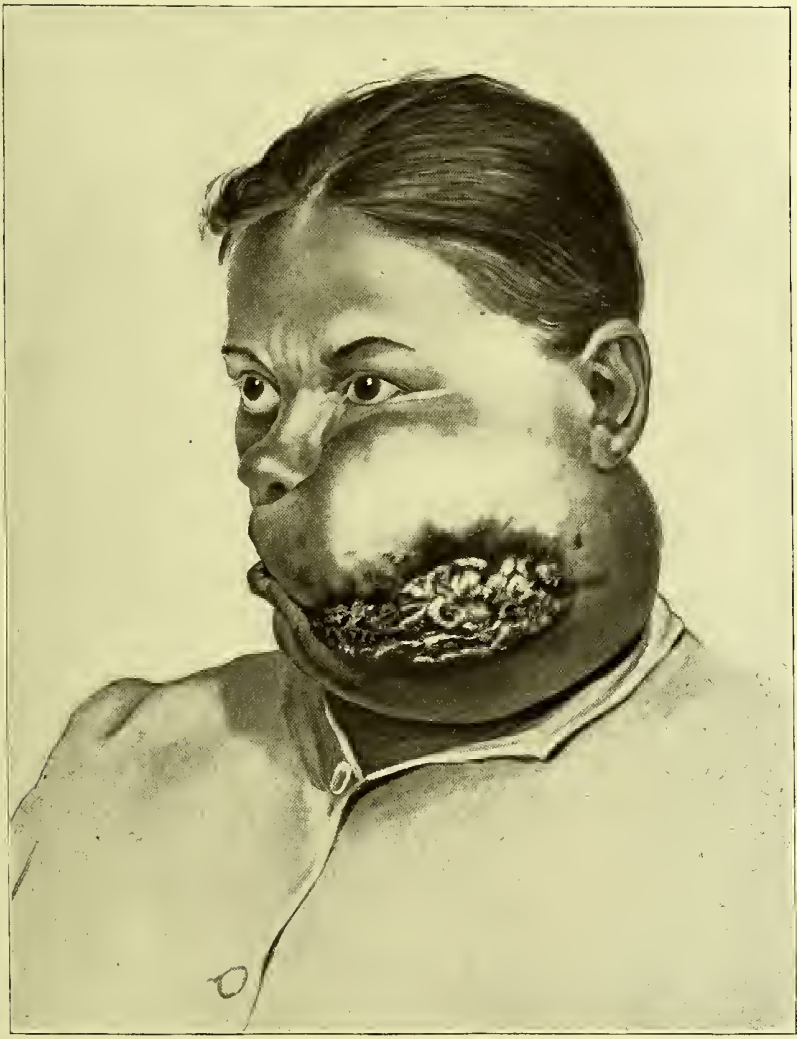


Endothelioma of parotid.

Goitre.

As a result of the most recent investigations we are justified in assuming that the internal secretion of the thyroid gland plays an important rôle in the economy. This secretion is composed of at least two important substances, one a globulin and the other a nucleoproteid. One or both of these may be toxic under certain conditions.

PLATE VII



Endothelioma of Submaxillary Gland.

During periods of unusual mental or physical strain the thyroid gland is often temporarily enlarged. These physiologic enlargements often occur at puberty, during pregnancy, and occasionally at the menopause.

A pathologic permanent hypertrophy of the thyroid gland occurs frequently in Switzerland and other mountainous districts, and has been attributed to the drinking of water derived from certain geologic strata.

In this country such pathologic enlargements occur more frequently as a result of some prolonged mental or physical strain, and in some instances they are accompanied by symptoms of nervous exhaustion, muscular weakness, and an increased heart action. Both the enlargement and the symptoms occasionally disappear on rest and the removal of the cause.

In other cases when the strain continues, a group of symptoms called Graves' disease, or exophthalmic goitre, results. In this condition there are progressive muscular weakness, moist skin, nervous irritability, rapid heart action, protrusion of the eyeballs, emaciation, diarrhœa, and if unchecked, great prostration, cyanosis, dyspnœa, and death. To this condition the term *hyperthyroidism* is also applied.

Children born without or with abnormally small thyroid glands develop slowly, are idiotic or imbecil, have a coarse, dry, thick skin, with areas of pseudo-œdema and a deficient growth of hair. These are designated as *cretins*. Certain adults, after destruction or removal of the thyroid gland, develop a similar group of symptoms, to which the term *myxœdema* is given.

The term goitre is generally applied to any hypertrophy or non-malignant tumor of the thyroid gland. Several clinical varieties exist.

Simple Hypertrophic or Parenchymatous Goitre.—In this condition the gland is simply increased in size without any noticeable change in its gross appearance on cut section. The enlargement is generally symmetric, but the hypertrophy may be limited to one lobe. As a rule, no symptoms are present other than those caused by the pressure of the tumor on the neighboring structures. In large goitres of this variety pressure on the trachea may give rise to cough or dyspnœa on exertion.

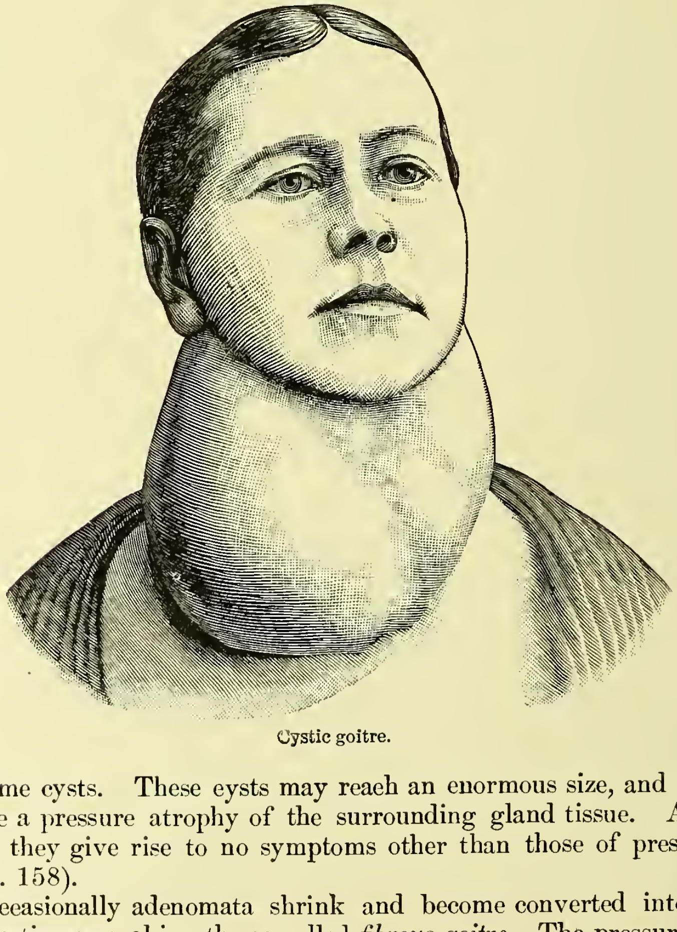
Colloid Goitre.—This differs from the parenchymatous variety in that the alveolar spaces are larger and contain more colloid material, and the epithelium is diminished in amount. Where the atrophy of the epithelial elements is extreme, symptoms of myxœdema are present.

Diffuse Adenomatous or Exophthalmic Goitre.—In these cases there is a great excess of epithelium with reduplication of the membrane filling the alveoli. The amount of colloid material is greatly diminished. This type is generally associated with symptoms of hyperthyroidism.

Circumscribed Adenomata.—Certain thyroid glands contain round or oval masses of glandular material separated from the rest of the gland by a thin capsule. These masses may be of the colloidal or exophthalmic type, that is, large spaces filled with colloid material or made up of more or less solid masses of epithelial tissue. These tumors are spoken of as *adenomata* of the thyroid gland.

Cystic Goitre.—Adenomata of the colloid type as they develop, present a diminishing amount of epithelial tissue, and eventually become cysts. These cysts may reach an enormous size, and may cause a pressure atrophy of the surrounding gland tissue. As a rule, they give rise to no symptoms other than those of pressure (Fig. 158).

FIG. 158.



Cystic goitre.

Occasionally adenomata shrink and become converted into fibrous tissues, making the so-called *fibrous goitre.* The pressure of these tumors may give rise to atrophy of the gland, which may result in a condition of *myxœdema.*

Carcinomata and *sarcomata* occasionally occur in the thyroid gland and are exceedingly malignant.

Treatment.—Simple enlargement of the thyroid gland without symptoms requires no treatment. Small adenomatous or cystic tumors, if they produce no symptoms, also may be disregarded. If, however, they show a tendency to enlarge, produce much disfigurement or cause pressure-symptoms, they should be removed. Exophthalmic goitre should be treated by rest, tonics, sea-bathing, hydrotherapy, and the removal of all causes of worry and anxiety. In certain exophthalmic patients, particularly advanced cases, where cyanosis, dyspnœa, and rapid emaciation are present, marked improvement and, in some instances, a positive cure can be brought about by the judicious use of Rogers' serum, a cytotoxin obtained from the blood serum of rabbits or sheep which have been inoculated with the neucleoproteid of human thyroid glands. If, after a reasonable period of rest and hygienic treatment, the symptoms are progressive, removal of half the thyroid is indicated, with a view to diminishing the secretion of the gland.

In cases of atrophy or destruction of the thyroid gland, when the symptoms of myxœdema are present, thyroid extract should be given.

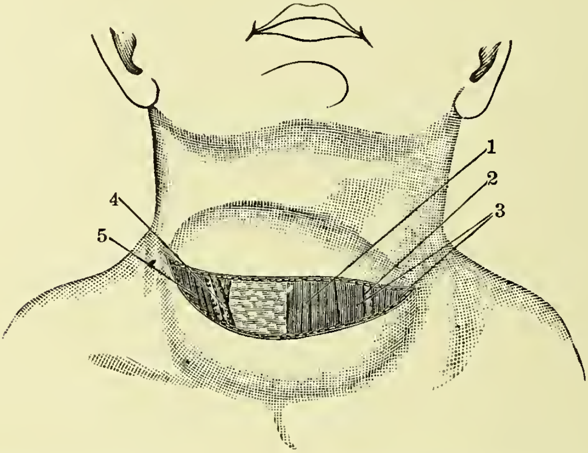
The operation of *thyroidectomy* is performed as follows : An incision four inches in length should be made along the anterior border of the sternomastoid muscle over the most prominent part of the tumor, and the fibres of the sternohyoid and sternothyroid muscles separated and retracted, exposing the capsule of the gland. The large thyroid veins should be divided between two ligatures and the gland carefully separated from the surrounding tissues. The superior and inferior thyroid arteries should be found, double ligated, and divided, great care being taken in severing the latter vessel to avoid injuring the cervical sympathetic and the recurrent laryngeal nerve. The gland may now be raised from its bed, the isthmus ligated with chromicized catgut, and the diseased half removed. The upper three-quarters of the wound should be closed, and a generous gauze drain introduced to control oozing. The drain may be removed at the end of thirty-six hours and the wound allowed to heal by first intention.

In the operation of thyroidectomy one should bear in mind the fact that beneath each lateral lobe of the thyroid gland are two small glandular masses, the *parathyroids*, which have an important function in the economy. If all four of these bodies are removed, tetany results. To avoid injury to these structures, Mayo advises leaving the posterior capsule of the gland. As this capsule is thin and often difficult to recognize, Halstead suggests, in addition, the avoidance of all clamps or ligatures upon the superior and inferior thyroid vessels and their branches, except those which are seen to enter the gland. In this way the blood supply of the parathyroid bodies is preserved.

Another important fact to be remembered is the frequent occurrence of symptoms of hyperthyroidism after operations upon exophthalmic patients. To guard against this grave complication the operator should avoid all rough handling of the gland and provide adequate drainage.

Kocher advises a transverse or collar incision in one of the natural creases of the neck. This necessitates section of the sternohyoid and sternothyroid muscles to thoroughly expose the gland,

Fig. 159.



Excision of a right-sided goitre by a transverse curved incision: 1, Sternothyroid muscle; 2, anterior jugular vein; 3, sternohyoid muscle; 4, oblique communicating jugular vein; 5, sternomastoid muscle. (Kocher.)

and requires more time and suturing to close the wound. It has, however, certain advantages in large tumors (Fig. 159).

Enucleation of cysts and adenomata is a comparatively easy procedure. The gland should be exposed as in the previous operation, the superficial layers of the gland incised down to the capsule of the tumor, which is then easily shelled out by the fingers or a periosteum elevator. A few bleeding points will require ligation, and the wound may be closed with a gauze or rubber tissue drain. After these operations it is well to keep the head quiet by means of a starch bandage carried about the neck, under the arms, and around the forehead.

Lupus occurs frequently on the face of young subjects, both in the form of lupus erythematosus and lupus vulgaris.

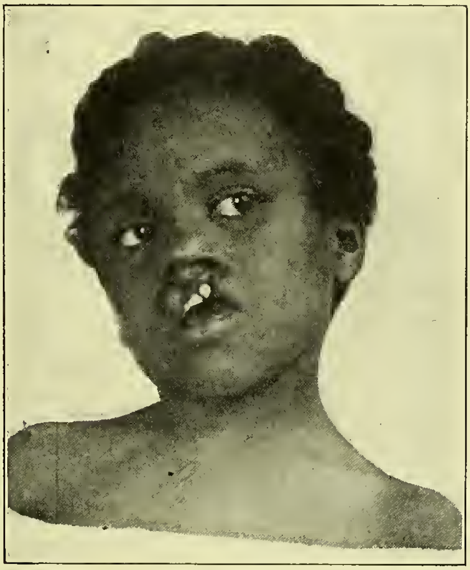
Tuberculosis cutis may occur about the mouth.

Scrofuloderma occurs on the neck in connection with suppurating lymphatic lymph-nodes. These conditions have already been described and their treatment outlined.

Harelip.

The various forms of harelip are due to a failure of union of the embryonic clefts between the internal nasal portions of the frontonasal process and the maxillary processes. If this occurs on one side only, a simple unilateral fissure results, which may or may not extend into the nasal fossa (Fig. 160). If it occurs on both sides, a Y-shaped fissure results, with wide separation of the maxillary folds below, and a bony defect on one or both sides extending to or through the alveolar process and palate, in the line of the fissure between the middle and lateral portions of the intermaxilla (Fig. 161). If the bony defect is bilateral, the central portion of the intermaxilla may project forward with the philtrum or central portion of the upper lip. This gives rise to a snout-like

Fig. 160.

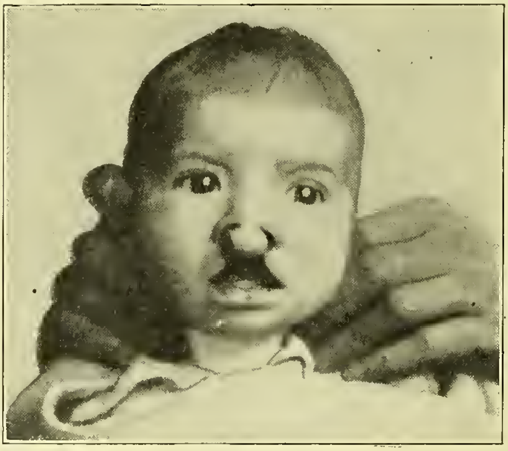


Single harelip.

protrusion containing the two central incisors. A simple median fissure may rarely occur in the upper or lower lip, or an oblique facial cleft extending along the nasofacial sulcus to the orbit. The simpler forms of harelip rarely give rise to serious disturbance. In the double variety, especially if combined with a cleft palate, the child may be unable to nurse and must be fed by a spoon or glass medicine-dropper.

Treatment.—The most favorable time to operate on a harelip is from the third to the sixth month, before the beginning of dentition. The operation for the closure of a cleft palate is usually deferred until the child is from two to three years of age, although in many instances of moderate deformity of the palate the operation may be performed at the same time that the lip is repaired. The operation for harelip should consist in freeing the tissues from the alveolar process until approximation can be easily effected without tension, paring the edges of the skin in such a way that the vermilion border of the lip, when the two sides are united, will project somewhat downward, in order to avoid the formation of a notch after contraction of the scar has taken place. The simplest method in unilateral harelip is that shown in Figs. 162 and 163. Silk sutures may be employed alone, or one or two fine silver wire sutures or harelip-pins may be introduced to bring the parts together if there is much tension, and the cutaneous and mucous edges united by fine silk or catgut. In the double harelip and projecting intermaxillary bone (Figs. 164 and 165) the

FIG. 161.



Double harelip.

latter should be loosened and forced back into place, if this is possible, or it should be cut off with bone-forceps. The cutaneous margins should then be freshened, as seen in Fig. 166, and united with silk, silver wire, or harelip-pins (Fig. 167). Many other

FIG. 162.

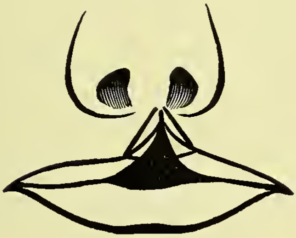


FIG. 163.

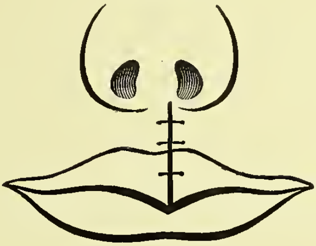


FIG. 164.

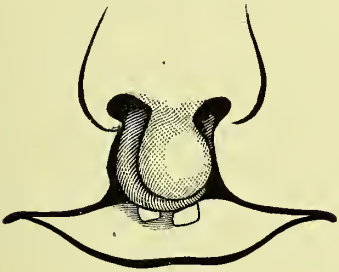


FIG. 165.

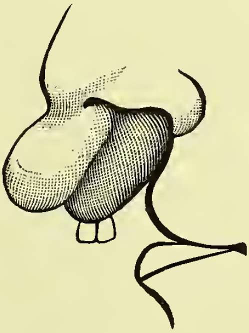


FIG. 166.

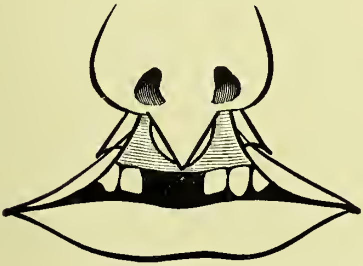
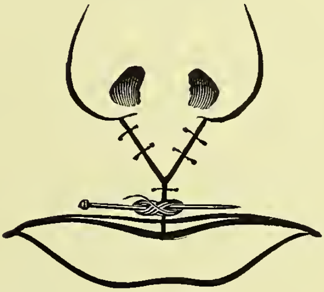


FIG. 167.



Varieties and remedial operations for harelip.

operative procedures have been suggested for the repair of this deformity, and are undoubtedly useful in meeting the indications in special cases; in the main, however, the simpler procedures will give the best results.

Cleft Palate.

This deformity consists in a failure of union of the various structures which enter into the formation of the roof of the mouth. The simplest form would be represented by the bifid uvula. The next degree would be a median fissure in the soft palate. The severer types would, in addition, present more or less complete fissures of the hard palate and alveolar process (Figs. 168, 169, and 170). In these complete forms of cleft palate the fissure may be in the median line opening into both nasal fossæ, with or without the presence in the cleft of the nasal septum; it may be on one side only, or it may be complete on one side and incomplete on the other. To understand the various forms of cleft palate, one should recall the fact that the roof of the mouth is formed by a union of the vertical ethmovomarine septum from the frontonasal plate, with the two lateral palatal segments of the maxillæ, which grow inward and join the septum about the tenth week of intra-uterine life. Fig. 171, after Rose and Carless, will show how arrest of development gives rise to the various clinical forms of the malformation.

Fig. 168.

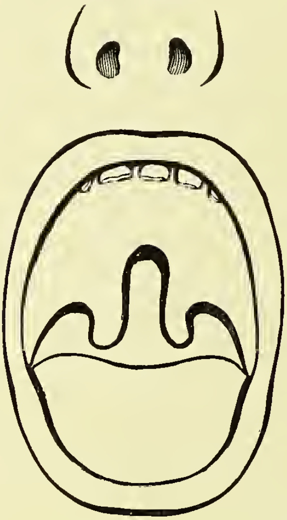
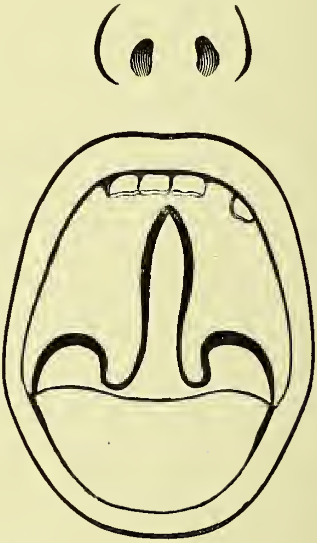


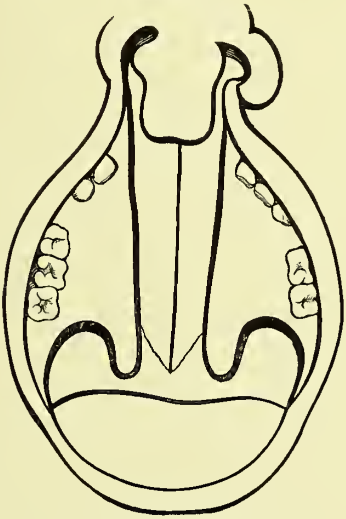
Fig. 169.



Types of cleft palate.

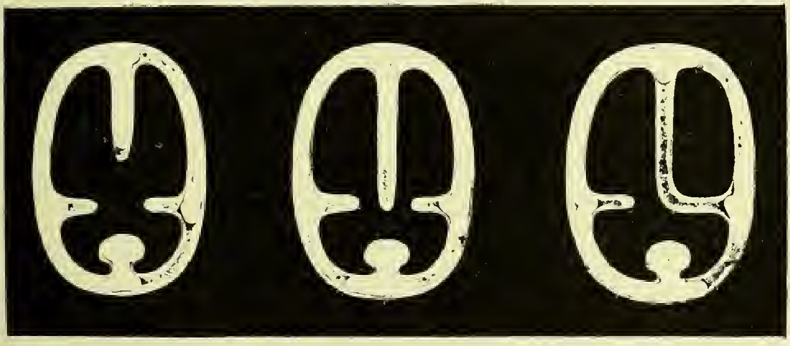
The **treatment** of cleft palate depends upon the degree of deformity and the tissues involved. In the past most authorities have advised that the operation be deferred until after the third year. When the cleft is limited to the soft palate the operation (*staphylorrhaphy*) consists in freshening the edges of the cleft and uniting them with silk sutures. The child is placed on a table with the head hanging backward over the edge, resting in the lap of the operator, who sits in a high chair. When the child is thoroughly anæsthetized, the mouth is held widely open by a Whitehead gag (Fig. 172) or some other suitable apparatus which separates the jaws widely and retracts the tongue. The tip of the uvula is next grasped with a pair of toothed forceps and drawn forward, putting the free edge of the velum on the stretch. A sufficiently generous strip of tissue is removed from the edge to leave a raw surface wide enough to insure adhesion with its fellow on the opposite side. When both edges have been prepared in this manner they are united with numerous stitches of fine silk introduced by means of a small, round, curved needle. If difficulty is experienced in drawing the edges together, the tension can, in a measure, be relieved by dividing the tendons of the tensor palati muscles as they pass around the hamular processes and by making curved incisions along the edge of the gums. If the cleft in the hard palate is only partial, by stripping the soft parts, including the periosteum, from either side of the fissure, they can be brought together and

Fig. 170.



Complete bilateral cleft palate.

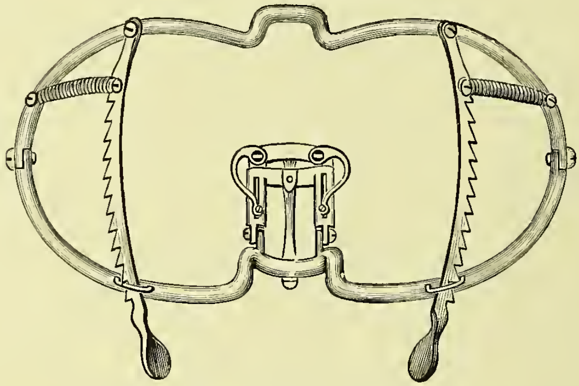
Fig. 171.



Showing formation of the various varieties of cleft palate. (After Rose and Carless.)

the cleft closed without disturbing the bone. When, however, this cannot be done, or when the cleft in the hard palate is more extensive, the operation of *uranoplasty* is indicated. In this the edges of the mucous membrane are freshened along the line of the cleft, and sutures introduced but not tied. Lateral incisions are then made parallel with the alveolar border and the bone divided throughout its entire length by a flat chisel and mallet. When both sides are freely divided, the detached bones are pressed toward the median line, the sutures tied, and the lateral wounds packed with iodoform gauze. The parts should be kept at rest for ten days or two weeks, only soft food being allowed. The use of a gutta-percha roof-plate is recommended after uranoplasty in older children and in adults, to protect the wounds during healing. The foregoing paragraphs represent the general consensus of surgical opinion in the past. Quite recently, Mr. Arbuthnot Lane, of London, has advanced views regarding the time of operation, and suggested changes in technic which promise far better immediate and remote results.

Fig. 172.



Whitehead's mouth-gag.

Mr. Lane believes that the full development of the upper pharynx and nasal chambers depend upon the early establishment of normal nasal respiration. To obtain the best functional results, therefore, the operation should be undertaken as soon after birth as possible. He is strongly opposed to any operation which forces the two halves of the hard palate together, as this tends to diminish the size of the nasal chambers. His method consists in constructing a mucoperiosteal flap with its base attached to the lateral margin of one side of the cleft. This flap may be made of ample size to fill even the largest gap, as at this early age it can be made to include the mucous membrane covering the alveolar border of the gums or inner side of the cheek.

He next raises the mucoperiosteum of the opposite side, from the border of the cleft well back to the alveolar process. Into the pocket thus created he draws the reflected flap from the opposite side and secures it in place by two rows of silk sutures. He also advises the reconstruction of the harelip, when present, at the same time.[1]

When no operative treatment seems desirable, the defect in the palate may often be remedied by a well-made dental plate.

DISEASES OF THE NOSE, NASOPHARYNX, AND ACCESSORY SINUSES.

Saddle-nose.

Depression or flattening of the bridge of the nose may occur as a result of trauma, septal abscess, syphilis, or tuberculosis. The deformity is an ugly one, and is best remedied by the method of Weir, which consists in making an incision along the nasofacial sulcus, freely separating the skin from the remaining portions of the bone and cartilage, and introducing a sterile plate of celluloid so fashioned as to restore the proper shape to the organ. Care should be taken to avoid wounding the mucous membrane of the nasal cavity. When the celluloid plate is in place the cutaneous wound is closed, without drainage, with fine silk sutures. Recently saddle-nose and other facial deformities due to loss of tissue have been successfully treated by the subcutaneous injection of sterile melted paraffin, which elevates the depressed scar-tissue and is easily molded into shape before it hardens. Paraffin melts at 115° F., and should be introduced by means of a well-heated metal aspirating syringe with a large needle. The needle should be introduced preferably at a short distance from the point where the paraffin is to be deposited.

Partial or Complete Destruction of the Nose.

Partial or complete destruction of the nose may result from malignant disease, syphilis, lupus, or trauma. It is sometimes remedied by *rhinoplasty*, which consists in grafting skin from some other portion of the body into the defective area. The two methods usually employed are by a flap from the forehead and by a flap from the forearm. In the former method the diseased tissues of the nose are removed, making a triangular wound, and an oval flap cut from the forehead, curved downward, and stitched in place as seen in Fig. 173. The columna is fashioned from the lower extremity of the flap and the nasal orifices kept patent by the insertion of two rubber tubes. In the arm method an oval flap is partly cut from the forearm, leaving a deep pedicle attached above. The arm is then carried upward to the face and the cut edge of the flap stitched to one side of the nasal wound. The arm is held in this position for a week or ten days by means of a plaster-of-Paris dressing. When union has taken place, the flap is completely severed from the arm, cut to fit the nasal opening, and stitched in place. The result of rhinoplasty in the majority of instances is unsatisfactory.

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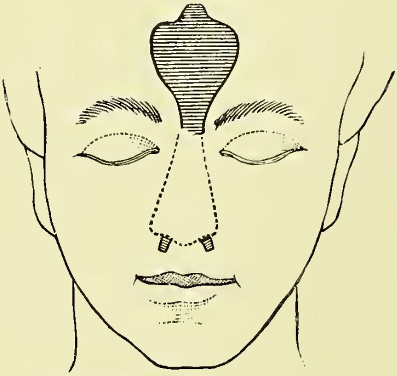
[1] For a more complete description of the various operative procedures applicable to the numerous types of cleft palate and harelip, the reader is referred to Mr. Lane's excellent monograph, *Cleft Palate and Harelip*, by W. Arbuthnot Lane, Medical Publishing Co. (Limited), London, 1908.

FIG. 173.



Rhinoplasty. Indian method modified. (Stimson.)

Foreign Bodies in the Nose.

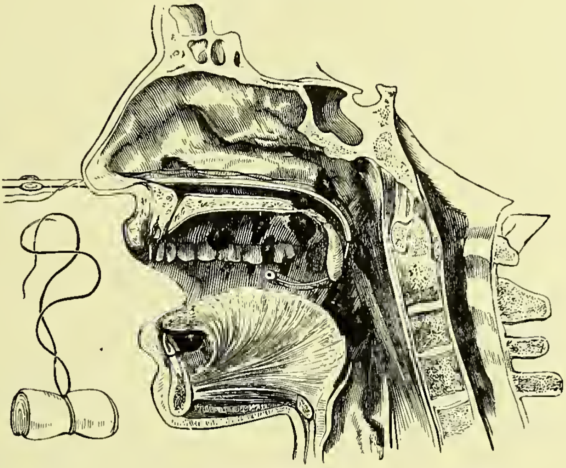
Buttons and other foreign bodies are frequently introduced into the nose by young children. They give rise to pain and a purulent rhinitis. The child should be etherized, cocaine or adrenalin applied to the mucous membrane, and the interior of the nares thoroughly examined by means of a nasal speculum and head-mirror. The foreign body can usually be found and removed by forceps.

Epistaxis.

Epistaxis, or bleeding from the nose, may occur from a blow upon the nose, or other trauma, from acute congestion, from violent blowing the nose, from sneezing, or from an ulcer of the septum or of the mucous membrane covering the turbinated bodies.

The **treatment** should consist in rest, cold applications, or the use of astringent sprays, as cocaine, adrenalin, antipyrin, or tannin. Park recommends equal parts of a 10 per cent. solution of antipyrin and a 10 per cent. solution of tannic acid. If the bleeding point is situated anteriorly, plugging the anterior nares with cotton or gauze will generally arrest the hemorrhage. If this fails, plugging the posterior and anterior nares will give prompt relief. To accomplish this, a soft-rubber catheter having a loop of silk or linen thread tied about its free extremity, or a Bellocq's canula (Fig. 174), armed with a similar loop, is passed through the nose into the pharynx. Through this loop is passed a loop of heavy twine, to which is attached a fine-meshed folded sponge or gauze pad. The loop is drawn outward through the nose and the sponge drawn snugly into the posterior nasal orifice. When this is secured, a second plug should be inserted into the anterior orifice and retained by tying the two arms of the projecting loop. This should be allowed to remain in place for from thirty-six to forty-eight hours, after which it can be removed by a third strand of twine which passes from the sponge outward through the mouth.

Fig. 174.



Plugging the nostrils with Bellocq's sound. (Fergusson.)

Acute Rhinitis.

Acute rhinitis may be caused by an infected wound, an intranasal furuncle, or by atmospheric influences. As a rule, it is treated by purely medical means. If, however, localized suppuration occurs, it should be treated by incision and subsequent irrigation with some mild antiseptic wash.

Chronic Rhinitis.

Chronic rhinitis, or nasopharyngeal catarrh, is generally due to some obstruction in the nasal canal or disease of the accessory sinuses. The chief causes of obstruction are deviations or spurs of the cartilaginous or bony septum, hypertrophied turbinated bodies, or polypoid tumors. These may be successfully removed by the snare, nasal saw, the Curtis nasal trephine, or the galvanocautery.

Ethmoiditis.

Ethmoiditis is an inflammation of the mucous membrane lining the ethmoid cells, which may give rise to necrosis of the bone. The symptoms of this condition are pain over the root of the nose, an abundant mucopurulent discharge, and the presence of nasal polyps. The disease is treated by providing better drainage for the cells by removing the polyps, an hypertrophied middle turbinated body if present, or by removing the necrosed bone plates by the curette.

Inflammation of the Antrum.

Inflammation of the antrum is usually a sequel of an acute septic rhinitis, the infection reaching the antrum by means of the foramen which opens into the middle meatus of the nose; it results also from suppurative disease of a tooth-socket.

The **symptoms** of the acute form are pain and soreness in the cheek, with neuralgic pains over the distribution of the second branch of the fifth nerve, fever, and tenderness of the upper teeth. Later, an abundant purulent discharge may appear from the nose, which gives marked relief to the symptoms. In the chronic form—*empyema of the antrum*—there are constant discomfort and neuralgia of the face, with an intermittent nasal discharge. Necrosis of the thin bony walls may occur, allowing the pus to burrow into the orbit or pterygomaxillary fossa, or it may break externally. When the pterygomaxillary fossa is invaded, there are stiffness of the jaw and a bulging of the temporal muscle, from the pus making its way upward behind the zygoma into the temporal fossa. Occasionally it points downward into the mouth near the last molar tooth. In the various forms of antral suppuration, as in other diseases of this and the other accessory sinuses, much may be learned by transillumination and the study of a well-taken *x*-ray plate. For the details of these special examination methods, the reader is referred to one of the standard works on Rhinology.

Treatment.—The treatment of the acute form is expectant. If relief does not occur promptly through the natural channel, the cavity may be drained by breaking an opening through the thin bony plate which separates the antrum from the inferior meatus of the nose. This can easily be done by a pair of sharply curved forceps introduced into the nasal cavity beneath the lower turbinated body and forcibly thrust through the thin septum into the cavity of the antrum, then opening the forceps and withdrawing them. The cavity can be irrigated through this opening by means of a soft-rubber catheter or curved irrigating-tube. In the chronic cases, in addition to nasal drainage, it is often necessary to open the antrum through the canine fossa, curette the cavity, and establish permanent drainage. If necrosis exists, a large part of the anterior wall can be removed through the mouth without external incision, the necrosed bone located and removed, and the entire cavity packed.

Abscesses of the pterygomaxillary fossa should be opened above the zygoma, and through this opening a dressing-forceps or other blunt instrument may be passed downward to the buccal cavity, and the space opened from below on this guide. A drainage-tube is then carried from the lower opening through the region of the abscess, and outward in the temporal region. Through this the diseased area can be frequently irrigated.

Inflammation of the Frontal Sinus.

Inflammation of the frontal sinus also results from extension of an inflammatory process upward from the nose through the infundibulum. The symptoms are severe throbbing, supra-orbital pain, and tenderness over the frontal bone. One or both sinuses may be involved. In neglected cases the bone is necrosed, pus may burrow into the orbit and cause exophthalmos (Fig. 175), or into the cranial cavity, giving rise to meningitis or cerebral abscess. In the chronic form a more or less constant headache, limited to the affected side, with evidences of slow septic absorption, may be the only symptoms. As in cases of empyema of the antrum, the presence of retained pus in the frontal sinus often may be detected by transillumination.

The **treatment** should be by incision along the upper margin of the orbit near the median line, retracting the superior margin of the incision well upward, and opening the sinus by means of a chisel and mallet. A small drainage-tube may be passed downward into the nasal cavity through the bony canal (which often must be enlarged) or the sinus may be packed until the inflammation has subsided, after which the cutaneous wound may be allowed to heal. To avoid the depressed scar which so often follows these operations, Killian advises leaving the supra-orbital ridge, opening the cavity both above and below this bony bridge.

When there is involvement of the ethmoid or sphenoid cells, these structures may be reached by carrying the original incision downward along the side of the nose, chiseling away the frontal process of the superior maxilla, and, if necessary, a portion of the nasal bone.

Inflammation of the Sphenoidal Sinus.

Inflammation of the sphenoidal sinus may occur from similar causes. Owing to its inaccessible position, treatment is rarely undertaken except by an experienced rhinologist.

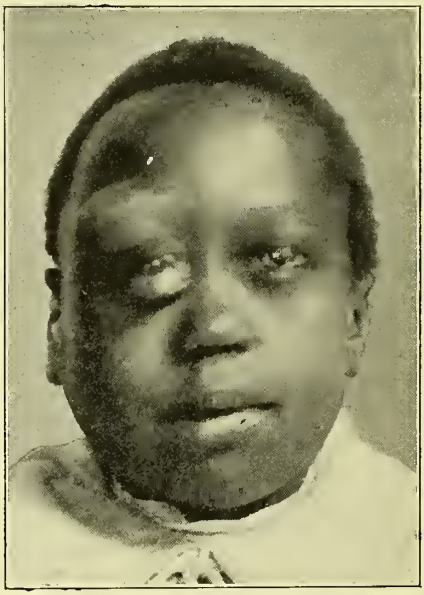
Tumors of the Nose and Nasopharynx.

Rhinophyma.—An overgrowth of the sebaceous elements of the skin, chiefly at the tip of the nose, resulting in great hypertrophy and dilatation of the vessels.

Treatment.—The treatment should consist in surgical removal of the exuberant masses, followed by skin-grafting.

Nasal Polypus.—These tumors occur frequently, and are generally due to some chronic suppurative disease of the ethmoid cells or middle turbinated body. They occur as large or small oval gelatinous bodies, which may be so numerous as completely to fill the cavity and produce total obstruction. They are pedunculated and are attached to the mucous membrane covering the two upper turbinates.

FIG. 175.



Exophthalmos from orbit infection.

The **treatment** should consist in removal with the Jarvis or

Bosworth nasal snare. Recurrence should be avoided by curing the original suppurative disease.

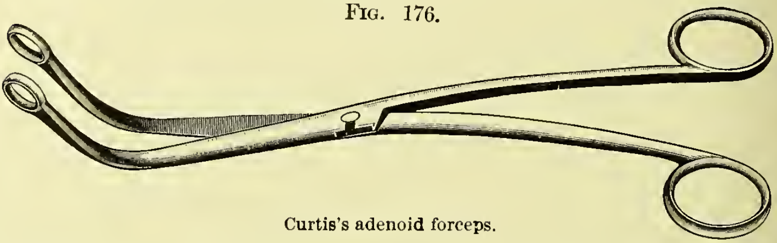
Nasopharyngeal or Fibrous Polypus.—This growth is in reality a fibrosarcoma which arises from the periosteum of the base of the skull at the vault of the pharynx. Its growth is at first slow, and as it produces no symptoms until it is of sufficient size to cause nasal obstruction, it is often overlooked in the beginning. It occurs generally in individuals between ten and twenty years of age. It may reach an enormous size, invading the nose, orbit, and antrum, causing great deformity of the face and often eroding the skull and involving the intracranial structures.

The **symptoms** are generally those of a catarrhal affection with more or less complete nasal obstruction and mouth-breathing; later, deformity occurs and pain from pressure on neighboring structures.

The **treatment** should consist in early and complete excision. If the growth is small, this can often be accomplished by a snare or galvanic écraseur introduced through the nose and manipulated into place by the finger introduced into the pharynx, or guided by means of the rhinoscope. When the tumor is larger it should be attacked through an external incision. By far the best procedure for these cases is the Langenbeck operation, which consists in an incision from the root of the nose downward in the nasofacial sulcus to a point just below the ala. This incision is carried to the bone, and the soft parts, including the periosteum, are raised with an elevator and retracted. The nasal bone, the nasal process of the superior maxilla, a part of the lachrymal bone, and a part of the nasal cartilage, are then removed with a chisel and mallet, and an opening established through which the finger may easily be passed to the upper part of the pharynx. Through this opening, and assisted by a finger introduced into the pharynx through the mouth, the growth can be accurately located, its pedicle isolated and divided. As the growth is sometimes lobulated, it may be necessary to divide it with scissors or the knife in order to remove it. Considerable bleeding may occur not only from the divided pedicle, but also from rupture of secondary attachments. If these can be located, they should be touched with the cautery, or if necessary the wound may be packed. The packing should be removed in forty-eight hours and the cutaneous wound closed with silk or silkworm gut. If the tumor is too large to be removed by this method, partial or complete excision of the superior maxilla may be necessary. If for any reason operation is contraindicated, Harmon Smith advises the injection into the tumor of a saturated solution of monochloracetic acid by means of a specially constructed syringe.

Adenoid Growths.—These hypertrophied masses of lymphoid tissue occur with great frequency in the vault of the pharynx and give rise to catarrhal symptoms, deafness, nasal obstruction, and infection of the cervical lymph-nodes. If neglected, the disease produces a marked and characteristic deformity of the face. There is widening of the root of the nose, the mouth is held half open, the incisor teeth may protrude, and the child gives the impression of being stupid or feeble-minded. This impression is accentuated by the often associated deafness.

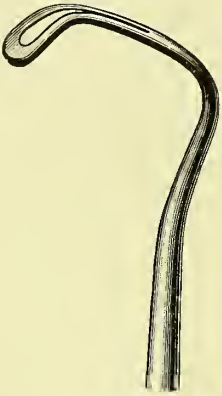
Fig. 176.



Curtis's adenoid forceps.

Treatment.—To remove these growths, the child should always be anæsthetized. The mouth should be held open by a mouth-gag, and the velum drawn forward with a piece of tape passed through the nares and out of the mouth, and tied over the lip. The operator should stand on the patient's right, and with the forefinger of the left hand introduced behind the palate the growth should be located. A pair of cutting adenoid forceps (Fig. 176) are then passed along the finger to the vault of the pharynx and the growth quickly removed. After the chief masses are removed, the remaining fragments may be scooped out by the Gottstein curette (Fig. 177). These cases bleed freely for a few moments, but the hemorrhage is easily controlled by an injection of hydrogen peroxide, 1 part to 8 parts of water. Considerable difficulty often is experienced in removing the masses about the opening of the Eustachian tube, and care should be taken to avoid wounding this structure.

Fig. 177.

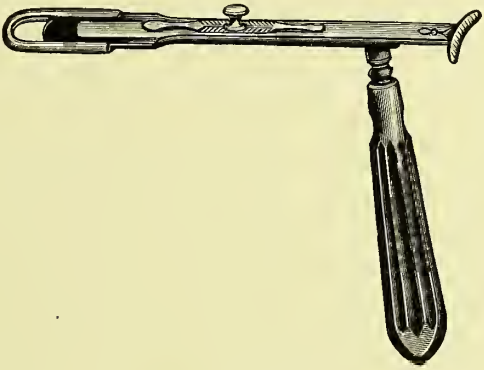


Gottstein's curette.

Enlarged Tonsils.—The tonsils are not infrequently the seat of a pathologic enlargement, which may produce a variety of symptoms. It is more common in children, as most lymphoid tissue hypertrophies have a tendency to diminish with advancing age. Thickness of speech, difficulty in swallowing, mouth breathing, nasopharyngeal catarrh, and a tendency to acute infection are the usual symptoms. There is also reason to believe that in many cases of tuberculous infection of the cervical lymph-nodes the bacilli gain entrance through diseased tonsils and adenoids.

Treatment.—Formerly surgeons performed tonsillotomy by means of the Mackenzie (Fig. 178) or some other form of tonsillotome, by which only a part of the gland was removed. Frequent recurrences led later to a more thorough removal by careful dissection.

Fig. 178.

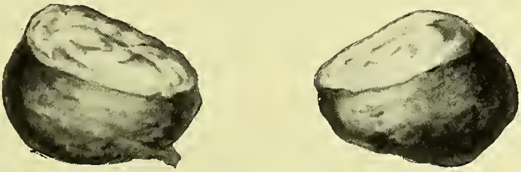


Mackenzie tonsillotome.

Recently Mathews[1] found that in children and in the majority of adults the entire tonsil could be enucleated by the finger (Fig. 179) if the mucous membrane at the summit of the tonsil between the anterior and posterior pillars was divided and the normal line of cleavage found.

This procedure is so simple, so easily performed, and so thorough, that it is to be recommended in preference to any of the older operations. The patient should be anæsthetized, the jaws widely separated and held by a mouth-gag. The tonsil should be grasped by a small vulsella, drawn outward, and the mucous membrane at its upper border divided with blunt scissors. The point of the closed scissors is next pushed through the cut for a short distance,

Fig. 179.



Enucleated tonsils.

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[1] *Annals of Surgery*, Dec., 1908.

and the surrounding tissues separated by partly opening the blades, after which the tonsil is easily stripped from its bed by the finger. After this enucleation, a thin strip of mucous membrane usually remains attached to its lower pole, which is divided with scissors or a wire snare.

Papillomata, sarcomata, and **epitheliomata** occur very rarely in the nasal fossa. Tumors of the antrum will be considered in the next section.

DISEASES OF THE MOUTH, PHARYNX, AND JAWS.

Stomatitis.

Stomatitis is an inflammation of the mucous membrane lining the oral cavity. It occurs as a result of a disordered stomach from the growth of fungi, as *Oïdium albicans,* from trauma, from syphilis, scurvy, or mercurial poisoning. As a rule, it requires only medical treatment.

Gangrenous Stomatitis.

Gangrenous stomatitis, or *cancrum oris,* is a spreading gangrenous ulcer appearing on the inside of the cheek or lip of a debilitated person. It affects young children chiefly, and especially those who live amid unhygienic surroundings and who are recovering from infectious diseases. It is comparatively frequent in adults suffering from scurvy. The disease usually starts from an abrasion of the mucous membrane due to a trauma, or from a roughened tooth. The surrounding area becomes necrotic and secretes a foul discharge, which often is swallowed by the patient. The process spreads rapidly, and unless checked by prompt surgical measures results in extensive destruction of tissue and grave septic symptoms. There is usually fever, occasionally with chills, sweats, and a rapid, feeble pulse. In other cases the sepsis may be of the asthenic type.

The **prognosis** is exceedingly grave.

The indications for **treatment** are to remove the necrotic area with the knife or curette and to apply powerful antiseptics, as pure carbolic acid, hydrogen peroxide, or formalin. An abundance of good food and judicious stimulation should be administered. and the mouth frequently washed with antiseptic washes.

Glossitis.

Glossitis is an inflammation of the substance of the tongue. It is caused by septic stomatitis, infected wounds, general toxic conditions, or mercurial poisoning.

The **symptoms** are pain and swelling in the organ and a limitation of its movements. The surface may be ulcerated from pressure on the teeth, and the swelling so great as to cause the tongue to protrude from the mouth and to interfere with respiration. The disease in some instances is limited to one side of the tongue; abscesses may form or the process may resolve. A particularly malignant form of glossitis has been described by Wright and others, which causes rapid gangrene of the organ and is apparently due to a specific micro-organism.

Treatment.—Apply leeches to the submaxillary region, ice to the tongue, and, if necessary, incise along the median line of the dorsum.

Chronic Superficial Glossitis.

Chronic superficial glossitis is a disease characterized by enlargement of the papillæ and the formation of cracks and other peculiar markings resembling superficial ulcerations. In other cases there is an overgrowth of epithelium, giving rise to opaque white patches (*leucoplakia*) or a scaly condition (*ichthyosis*). These conditions may or may not be associated with pain, and are important on account of the fact pointed out by Butlin, that they are very liable to be followed by cancer of the organ.

Tonsillitis.

Tonsillitis is of interest to the surgeon for the reason that it is the immediate cause of peritonsillar abscesses, and often is the remote cause of chronic hypertrophy of the tonsil and glandular enlargements of the neck.

Peritonsillar Abscess.

Peritonsillar abscess is a cellulitis of the tissues above and around the tonsil. It generally follows an acute streptococcus tonsillitis, and is characterized by œdema, induration, and redness of the palate immediately above the tonsil. The disease is a painful one, and is accompanied often by fever, chills, and severe toxæmia. On examination of the throat with the finger, a distinct induration generally can be made out, and is the guide for the incision, which constitutes the only rational method of treatment. In making the incision the knife should penetrate the tissues for a distance of only half an inch; and if pus is not reached, a grooved director or stiff probe should be introduced into the wound and thrust in various directions until the pocket of pus is reached. Cocaine may be used, although it is rarely of much service, as the pain is due more to the pressure than the cutting. If general anæsthesia is employed, the head should be allowed to hang backward over the edge of the table to avoid asphyxiation from the flow of pus into the larynx and trachea.

Retropharyngeal Abscess.

Retropharyngeal abscess is a collection of pus between the spinal column and the posterior wall of the pharynx. It is due generally to caries of the vertebral column or base of the skull, rarely to septic osteomyelitis of the body of the axis or arch of the atlas. It occasionally develops as an acute affection from wounds of the pharynx, or from suppuration of the nasal cavity in children.

The **treatment** should if possible be by external incision behind the sternomastoid muscle, locating the abscess by a probe or director, and enlarging the opening by a sinus-dilator or dressing-forceps. Incision through the pharyngeal wall may be necessary if the abscess points in that direction.

Inflammation of the Salivary Glands.

Infection is carried to the salivary glands by the bloodvessels, lymphatics, or by the ducts. The glands become swollen, hot, and tender; pain is present, and fever may develop. The process ends either in resolution or suppuration. The treatment of suppuration in these glands has been considered under the headings of Abscess of the Parotid and Angina Ludovici.

Osteomyelitis of the Jaws.

In the great majority of instances osteomyelitis of the jaws is caused by suppuration around the root of a carious tooth. When this occurs, the pus may loosen the tooth, find its way along the wall of the socket and infect the gum, forming a "gum-boil"; or it may infect the bone, causing an osteomyelitis, which may be limited to the region of the tooth or spread throughout its entire structure. In the first instance it causes a small area of necrosis, through which the pus reaches the surface and collects beneath the periosteum, forming an *alveolar abscess,* which in turn may infect the surrounding tissues and eventually rupture externally. When the inflammation involves a large portion of the bone, the area of necrosis may be very extensive, subperiosteal abscesses form and rupture, and the periosteum eventually develops an involucrum, in the centre of which the necrosed portion of bone or sequestrum is imprisoned.

The **diagnosis** of simple alveolar abscess is readily made by observing the features already mentioned, pain and tenderness, and a limited area of swelling and fluctuation. In the more extensive forms generally there is a history of an ulcerated tooth, followed by swelling of the cheek, jaw, or submaxillary region, and the formation of abscesses. These continue to discharge in spite of careful treatment, and there gradually develops a thickening of the bone which may be localized or general. A probe introduced into one of the sinuses will generally detect bare bone.

Treatment.—Early incision down to the bone often will abort the process. In many instances, however, the case is not seen by the surgeon until necrosis has taken place. In these instances, if the process is limited in extent, free incision through the mouth, with removal of dead bone by a sharp spoon or the chisel, and subsequent packing of the cavity with iodoform gauze, constitutes the best treatment. When extensive areas of necrosis are present, drainage should be provided by free incisions, which if possible should be made from within the mouth. At a later period, when the involucrum is well formed, it may be opened and the loose sequestrum removed. Whenever it is possible, these operative procedures should be carried out from within the oral cavity, as the scars from such extensive external incisions are unsightly. If, however, a number of sinuses are present, it may be necessary to attack the disease from the outside. The radical operation should not be undertaken until the sequestrum is loosened and can be removed without too great damage to the involucrum. The usual practice of simply opening down to the bone and scraping it, is of no value whatever, and serves only to increase the deformity. At best the treatment of extensive osteomyelitis of the lower jaw is unsatisfactory. When the process attacks the upper jaw, the results, as a rule, are better for the reason that usually less extensive areas are involved.

Tumors.

Cysts of the floor of the mouth may be produced by obstruction and dilatation of the ducts of the mucous glands (*ranula*), or more rarely by dilatation of the ducts of the sublingual gland. They appear just beneath the mucous membrane of the floor of the mouth on either side of the frænum, and may grow to the size of a hazelnut or robin's egg. They are semitranslucent and contain a clear mucoid fluid.

The **treatment** should be by complete excision or by removal of a portion of the cyst-wall and the application of pure carbolic acid to the remaining portion. Cysts occasionally occur just beneath the mucous membrane of the lateral wall of the pharynx, and are, as a rule, of branchial origin. Their treatment should be by excision, preferably from without.

Epithelioma may occur as a primary affection in the tongue, floor of the mouth, the cheeks, the gums, the palate, or in the tonsil. It may affect the jaws secondarily. As a rule, the disease appears late in life, and in the first four situations it is apt to follow severe chronic irritation from the friction of a ragged tooth or the habitual use of tobacco. Great enlargement of the lymph-nodes of the neck may accompany comparatively small epitheliomata of the mouth. On the cheek the growth is apt to start near the angle of the mouth; in the gums, around the stump of a decayed tooth. The disease is recognized by its slow growth, its indurated borders, its steady progress, and by involvement of the lymphatics.

Cancer of the tongue is by far the most frequently observed type of malignant disease of the oral cavity. It occurs commonly in men past middle life. It may arise spontaneously or as a result of some chronic irritation. In not a few instances it is apparently engrafted upon a gummatous infiltration of the organ or upon a long-standing leucoplakia.

Symptoms.—Several clinical types of the disease are to be recognized: first, the superficial ulcer which occurs on the lateral margin of the tongue often opposite a carious tooth; second, a gradual enlargement of one of the circumvallate papillæ; third, a fissure of the tip or dorsum; fourth, a hard nodule in the mucous membrane, which later ulcerates and resembles the first variety. All of these lesions are superficial at first, but later infiltrate the muscles and cause dense induration. When the disease is engrafted upon a leucoplakia or gumma, it is often difficult to arrive at an early diagnosis, and valuable time is lost before radical treatment is inaugurated. In all types the growth at first is slow; later it advances more rapidly, and is accompanied by pain, difficulty in speech or deglutition, and eventual enlargement of the submaxillary lymph-nodes.

Prognosis.—The prognosis in cancer of the tongue, while formerly regarded as extremely unfavorable, has of late been looked upon as more encouraging, owing to its earlier recognition and more thorough methods of operation. Mr. Butlin, of London, has recently published a report of 197 personal operations in unselected cases with an operative mortality of a trifle less than 11 per cent., and 27 per cent. of cures after three years. In 70 cases, where he removed the entire contents of the submaxillary triangle, 24 (or 42 per cent.) were alive at the end of three years. In cancer in other parts of the oral cavity the prognosis is less favorable.

Treatment.—The treatment should be early and complete excision, with removal of the anatomically related lymph-nodes and the lymph-bearing areola tissue of the neck. These operations will be described on page 350.

Sarcoma may occur in the gums, palate, jaws, tonsils, and in the adenoid tissue at the base of the tongue. In the two latter situations the disease is of that exceedingly malignant variety called lymphosarcoma. Several forms of sarcoma affect the tissues of the jaw, the least malignant of which is the giant- and mixed-cell variety of the alveolar border, called *epulis*. Periosteal sarcoma, spindle- or round-cell, may occur on any part of the superior maxilla, but is more common on its anterior surface or alveolar process. Both the periosteal and the central variety may affect the mandible. Slow-growing localized or diffuse hypertrophy of the jaw has been twice observed by the writer which, upon gross inspection, resembled a normal formation of new bone, but which strongly suggested chondrosarcoma under the microscope. Further observation made it probable that the disease was that described in another chapter as liontiasis.

Sarcomata originating in the mucoperiosteum of the antrum are common, and their growth is often rapid, bulging the walls of this cavity and encroaching upon the nasal chamber, the orbit, the sphenomaxillary space, and the mouth.

"Sarcoma of a tooth-follicle occurs only in children, and is particularly apt to involve the germ of the first permanent molar" (Bland Sutton). It is recognized by its rapid growth and the other characteristics of sarcoma already mentioned. The treatment is early and complete removal.

Adenoma.—An encapsulated adenomatous tumor occasionally occurs in the tissues of the soft palate. It is round or oval in shape, and may attain the size of a hen's egg. It is not malignant. It should be removed by enucleation. A rare and exceedingly rapidly growing tumor of the palate, resembling the above-mentioned palatine adenoma, may occasionally be encountered, which is extremely malignant. It also occurs in the region of the gums, probably from aberrant masses of salivary gland tissue. It is classed by Volkmann among the *endotheliomata*.

Osteomata, papillomata, angiomata, lymphangiomata, and **lipomata** occasionally occur in these regions, but possess no special features. Their treatment has already been considered.

Odontomata and Dental Cysts.—These tumors are often loosely spoken of as *dentigerous cysts*. They may occur in either jaw, and are much more frequent than is generally supposed.

Bland Sutton has classified these tumors as follows: An *epithelial odontome* is a tumor growing from the enamel-organ of the tooth, and made up of small cysts containing a brownish fluid. It is encapsulated and may distend the bone. A *follicular odontome* is an expanded tooth-follicle containing a viscid fluid and an imperfectly developed tooth. A *fibrous odontome* is a greatly thickened tooth-sac which forms a dense layer of fibrous tissue around a tooth, preventing its eruption. A *compound follicular odontome* is a tumor made up of cementum, dentine, and often a large number of imperfectly developed teeth, an incomplete ossification of the tooth-capsule. A *radicular odontome* grows from the root of the tooth, and is made up of dentine and cementum, but no enamel, as the tumor develops after formation of the crown of the tooth, which does not undergo change. A *composite odontome* is an irregular bony tumor occurring in the jaw-bone or in the antrum, made up of cementum, enamel, and dentine. It may reach a large size.

These tumors are often regarded as osteomata, osteosarcomata, and other forms of new growth. The true diagnosis is rarely made before the operation. They should be removed with a chisel and mallet or with bone-forceps. In the cystic variety it is often only necessary to open the cavity, curet, and pack.

Gummatous infiltration of the tongue, tonsil, palate, and pharyngeal wall occurs frequently, and must be distinguished from new growths. It occurs first as a rapidly developing tumor, which soon breaks down, leaving large necrotic ulcers and often resulting in extensive losses of tissue. In the tongue the process is often a slow one; in the palate, tonsil, and pharynx it is frequently one of great rapidity, enormous sloughs occurring in a few days following the first symptoms. These lesions are characterized by absence of pain, by their rapid destruction of tissue, and by their prompt improvement under antisyphilitic treatment.

Tuberculous ulceration of the tongue is rare, and generally is secondary to lung tuberculosis. It occurs on the side near the tip, as a ragged, undermined ulcer surrounded by soft tuberculous nodules. In other cases it is simply a superficial erosion surrounded by a slightly elevated hard border. There is, as a rule, no deep or massive induration. Tuberculous ulcerations in other parts of the oral and pharyngeal cavities are extremely rare. They are often the seat of spontaneous pain, differing thereby from the syphilitic lesions.

OPERATIONS ON THE TONGUE, MOUTH, PHARYNX, AND JAWS.

Removal of the Tongue.

Partial or complete removal of the tongue may be accomplished through the mouth (Whitehead) by the submaxillary operation (Kocher) or by one of the several methods by which access to the region is gained by division of the jaw.

In all operations for malignant disease of the tongue one should strive to imitate in thoroughness the modern operation for breast cancer. Thus in small superficial lateral erosions without enlarged glands, one-half of the tongue should be removed, together with the submaxillary gland, all the areolar tissue, and lymphatics of the submaxillary triangle. Where the disease is more advanced, with palpable lymph-nodes, the entire lymph-bearing areola tissue of the lateral aspect of the neck should be removed, as well as the submaxillary gland, the sternomastoid muscle, and often the internal jugular vein. When the disease approaches or passes the midline of the tongue, the entire organ should be removed. Where the disease is at all advanced, that portion of the floor of the mouth containing the infected lymph channels should be thoroughly removed with the submaxillary tissues. It is only by these radical procedures so strongly advocated by Crile that satisfactory results can be expected.

Before any operation on the tongue the patient should have all carious teeth filled or removed; and for several days prior to the operation the oral cavity should be frequently disinfected by washes of hydrogen peroxide, listerine, or boric acid. Ether should be administered by means of Crile's nasal tubes and the pharynx packed with gauze; or, as suggested by Butlin, a preliminary thyrotomy may be employed for anæsthesia. If the Whitehead procedure is followed, the jaws should be held apart by a mouth-gag; the tongue should next be firmly grasped by a vulsellum forceps and drawn upward and outward. It should then be severed from its connections at the floor of the mouth and hyoid bone by means of heavy blunt-pointed scissors. The lingual arteries should be clamped as they are cut, and subsequently ligated with chromicized catgut or silk. If the Kocher method is employed, an incision should be made along the course of the digastric muscle from the symphysis of the jaw to a point just below the lobule of the ear, dividing the skin, superficial fascia, and the platysma muscle. The flap is dissected from the deeper parts and drawn upward with a retractor. The deep fascia is next divided in the line of the original incision, and this with the submaxillary and sublingual glands, the lymphatics, and the areolar tissue of the part, thoroughly removed. The lingual artery is found beneath the hyoglossus muscle and ligated. If the entire tongue is to be removed, the lingual artery on the opposite side is also exposed and ligated. The floor of the mouth is then divided by an incision along the ramus of the jaw, and the tongue drawn downward through the wound by means of a vulsellum forceps or sharp hook. Partial or complete excision can then be performed with scissors. After removal of the diseased area the mucous membrane of the floor of the mouth should be partly united, the external wound packed or partly closed with sutures and drained. As in all other mouth operations, scrupulous care should be taken to limit the local infection and to remove its products. The patient should be fed by the rectum for one or two days, after which food should be administered by means of a stomach-tube. The cavity of the mouth should be washed every hour at first, with weak hydrogen peroxide, boric acid, or myrrh wash.

Von Langenbeck's Operation for Removal of the Tongue, Tonsil, Floor of the Mouth, and Palate.

An incision is made from the angle of the mouth to the junction of the anterior margin of the masseter muscle with the lower border of the mandible, and from this point downward and forward toward the great cornu of the hyoid bone. The lower half of the incision is carried down to the sheath of the vessels and the external carotid ligated. The submaxillary gland and the lymphatics of the submaxillary triangle are next removed, after which the upper part of the incision is carried through the cheek to the bone. A Gigli saw is then passed behind the ramus of the jaw through the floor of the mouth and the bone sawn in an angular fashion to prevent subsequent displacement. The two extremities of the divided bone are then retracted by sharp hooks and the diseased tissues readily removed by scissors or the knife. After this is accomplished the mucous membrane should be united whenever this is possible, the bone drilled and sutured together with chromicized catgut, and the cutaneous wound accurately coapted with sutures or harelip-pins. This operation gives the best exposure of the parts, but is open to the objection that the bone occasionally fails to unite and necrosis may result.

When the disease is situated near the tip or is bilateral, division of the jaw in the mid-line, Sedilot's operation, is to be recommended.

Cheever's Lateral Pharyngotomy.

An incision is made along the anterior border of the sternomastoid muscle from the lobule of the ear to a point opposite the cornu of the thyroid cartilage, and the structures divided down to the deep fascia, which is opened. The external jugular and temporofacial veins are divided between two ligatures and the carotids and the deep jugular retracted outward. The digastric, stylohyoid, and stylopharyngeus muscles are divided or retracted and the glossopharyngeal and hypoglossal nerves avoided. The lateral wall of the pharynx may then be incised on a sound or finger introduced through the mouth, and any growth in the region of the tonsil or superior laryngeal aperture removed. After careful hæmostasis and disinfection, the wound in the pharynx should be tightly closed with two layers of fine silk and the superficial structures united, drainage being provided for at the lower angle of the wound.

Removal of the Upper Jaw.

After preliminary ligation of the external carotid an incision should be made along the lower border of the orbit, the nasofacial sulcus around the ala of the nose to the median line, and from there downward through the upper lip to the mouth. The incision should be carried to the bone and the flap retracted outward, exposing the entire anterior surface of the superior maxilla. The central upper incisor tooth on the affected side should then be drawn and the alveolar process and hard palate divided by means of a saw introduced through the anterior nares or by a heavy bone-forceps. The nasal process is next divided by the forceps and the zygoma cut near its maxillary extremity. The bone should then be grasped by a strong pair of lion-jawed forceps and wrenched from its posterior attachments. Considerable bleeding is apt to follow this procedure, largely from the pterygoid plexus of veins, which must be controlled by packing. After this has been accomplished the parts should be thoroughly inspected for evidences of disease, which, if found, can easily be removed by the forceps or bone-curette. The skin flap should be replaced and united with silk-worm gut or silk sutures, with or without one or more harelip-pins in the upper lip.

Removal of the Lower Jaw.

To remove one-half of the lower jaw, make a vertical incision through the lower lip to the symphysis of the chin, then along the inferior border of the horizontal ramus to the angle, then upward for a short distance toward the lobule of the ear. The soft tissues should be removed from the bone by dividing the mucous membrane along the alveolar border and severing the muscular attachments with an elevator. The symphysis is next divided by a Gigli saw. The tissues forming the floor of the mouth should then be cut close to the bone and the ascending ramus exposed by an incision along the mucous membrane and drawing upward of the musculocutaneous flap. When the entire half of the bone is exposed, the horizontal ramus is depressed until the attachment of the temporal muscle can be seen and divided. The internal pterygoid muscle should be detached from the inner surface by an elevator, the inferior dental vessels and nerves severed, and the capsule of the joint exposed and opened from in front. In disarticulating, care should be taken to avoid wounding the internal maxillary artery, which lies between the neck of the jaw and the internal lateral ligament. The soft parts should then be replaced and united with harelip-pins, silk or silk-worm gut, and union of the mucous membrane within the mouth brought about as far as possible by stitching with catgut. If it is necessary to remove the entire mandible, the second half may be taken out in the same manner. Partial resection of the lower jaw is frequently necessary for osteomyelitis or epulis, and can generally be effected through the mouth without external incision.

DISEASES OF THE LARYNX, TRACHEA, AND ŒSOPHAGUS.

Injuries of the larynx, trachea, and œsophagus have been considered in the earlier part of the chapter.

Œdema of the Glottis.

Œdema of the glottis is a swelling of the mucous membrane and submucous areolar tissue about the larynx and vocal cords, giving rise to dyspnœa, stridor, loss of voice, and often complete respiratory obstruction leading to sudden death. The causes of œdema of the glottis are acute laryngitis from catarrhal or septic inflammation of the neighboring structures, as diphtheria, peritonsillar abscess, angina Ludovici; from the inhalation of live steam, irritating or heated vapors ; from traumata, tuberculous or syphilitic ulcers, new growths, chronic cardiac or renal disease.

The **treatment** of this condition is, in the milder cases, by applications of a solution of cocaine or adrenalin to the larynx, steam inhalations, and the internal administration of cathartics and aconite. Whenever the symptoms threaten complete obstruction or are progressive in character, intubation of the larynx or tracheotomy should be performed.

Foreign Bodies in the Larynx or Trachea.

Particles of food and other solid bodies are occasionally aspirated from the mouth into the air-passages. The accident occurs most frequently in children and in vomiting patients during or after the administration of a general anæsthetic. The foreign body may lodge in the larynx, trachea, or one of the bronchi.

Foreign bodies in the larynx give rise to an immediate fit of violent coughing, spasm of the glottis, cyanosis, and often vomiting, during which the foreign body if small may be expelled. If the body lodges in the trachea, the symptoms are at first similar, but are soon relieved if the irritating substance becomes fixed below the larynx. Coughing, however, may cause a renewal of the dyspnœa and spasm by again driving the intruder upward against the vocal cords. If the foreign body passes into one of the bronchi (generally the right), more or less obstruction may develop to the ingress and egress of air, which is apparent by auscultation; and if the obstruction remains, pneumonia, lung abscess, or gangrene may result, or erosion of a bloodvessel and fatal hemorrhage. Exceptionally a foreign body may remain for years in the lung without giving rise to untoward symptoms.

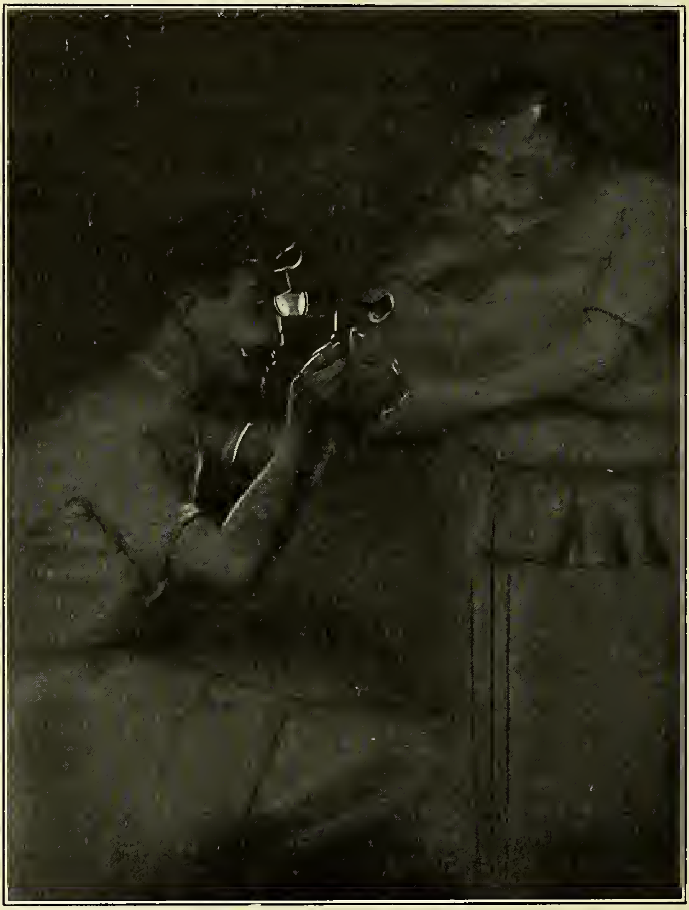
Treatment.—Foreign bodies in the upper part of the larynx can frequently be seen by the laryngeal mirror and removed by forceps. If the body lies below the vocal cords, give ether and invert the patient, striking the back violently with the flat of the hand. This may dislodge the body and it may be expelled. If this is unsuccessful, perform high tracheotomy, holding the edges of the tracheal wound wide apart, and repeat the process or use long, thin-bladed forceps. Foreign bodies in the lower part of the trachea or primary bronchi may occasionally be reached by forceps through a low tracheotomy wound. If the body is lodged in one of the smaller bronchi, the prognosis is exceedingly grave, as it can be removed only by an operation through the chest wall. During the past few years the method of removing foreign bodies from the trachea and bronchi by means of Killian's bronchoscope has steadily grown in favor. This instrument is simply a long metal tube highly polished on the inside, which is carried into the trachea or bronchi through the mouth or through a tracheal wound. A strong column of light from a frontal electric lamp enables the operator to detect the presence of the foreign body, which can then be removed by specially constructed forceps or hooks. Considerable technical skill is required, but a number of cases are on record where foreign bodies have been located and removed from regions as remote as the second division of the bronchial tube (Fig. 180).

Foreign Bodies in the Œsophagus.

Foreign bodies in the œsophagus are much more common, as coins, marbles, false teeth, and many other articles are frequently swallowed and lodge in the œsophagus.

The **symptoms** of a foreign body in the œsophagus are localized pain, dysphagia, and salivation. The position of metallic bodies can be located by the metal œsophageal bougie or the *x*-ray. The location of other bodies can usually be determined by passing bougies of various sizes to the point of obstruction. The three narrowest parts of the tube are at its commencement, about three inches below this point, and at the œsophageal opening in the diaphragm.

FIG. 180.

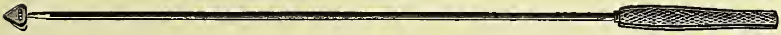


Upper bronchoscopy. Dorsal position.

Treatment.—Swallowing quantities of soft bread, mush, or potato will occasionally carry a foreign body into the stomach. Coins may often be removed by the coin-catcher (Fig. 181); other substances by the œsophageal forceps or the horse-hair probang

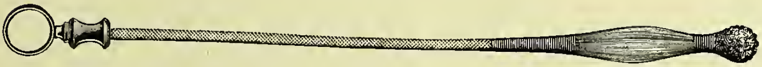
(Fig. 182), which should be introduced closed beyond the foreign body, opened, and withdrawn. If these measures fail, perform external œsophagotomy and attempt removal by the forceps. This is usually successful for bodies lodged in the first six inches of the tube. When the foreign body is lodged deep in the thoracic portion of the œsophagus the œsophagoscope may be employed. When this is not available, have the patient swallow a long piece of silk thread, the upper end of which is secured by tying to the ear or to a button on the patient's clothing. When there is reason to believe that the thread has passed into the stomach, perform gastrostomy, pick up the thread on a curved probe introduced into the stomach, and with this draw downward a piece of heavy braided silk or bass line, in the centre of which is tied a mass of gauze, a rubber or metal cup. This contrivance is drawn downward into the stomach in the hope of bringing with it the foreign body. The author on one occasion was in this way able to remove a detached metal bulb from an œsophageal bougie lodged between two dense strictures in the thoracic portion of the œsophagus. (The bulb and the "parachute snare" are shown in Fig. 183.) If this fails, resort must be had to the method of Enderlen for opening the posterior mediastinum by resection of the fifth, sixth, seventh, and eighth ribs on the left side near the spine, separating the pleura and exposing the œsophagus.[1]

FIG. 181.



Coin-catcher.

FIG. 182.



Horse-hair probang.

Stricture of the Œsophagus.

Stricture of the œsophagus is generally due to swallowing some corrosive substance, as lye or strong acid, to the irritation of a foreign body, to the healing of ulcers, to new growths, to the pressure of an aortic aneurism, or to hysteric spasm. When due to the swallowing of a corrosive substance (the commonest

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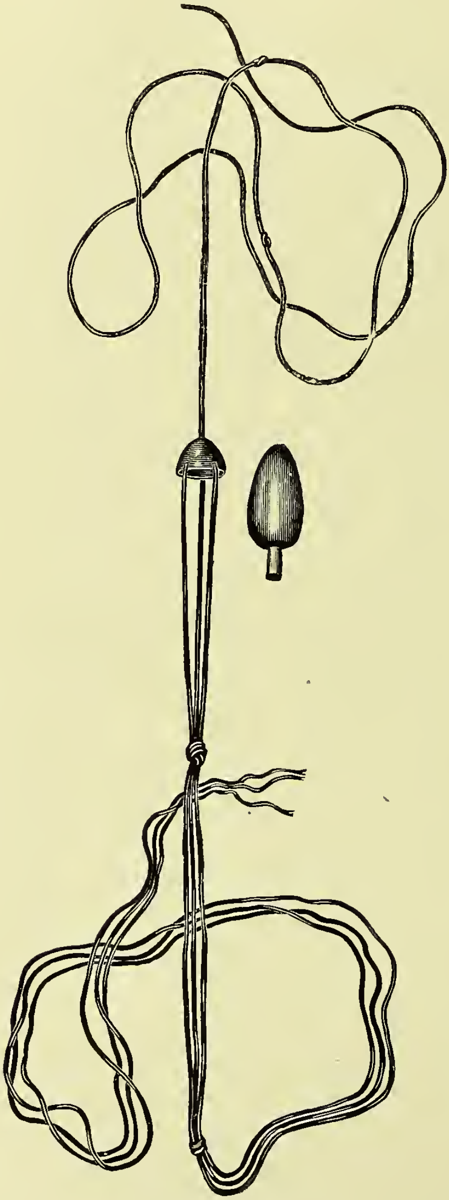
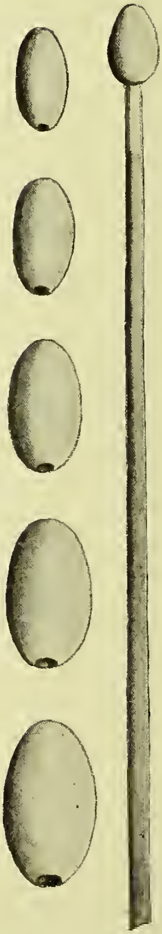
[1] Deutsche Zeitschrift für Chirurgie, Bd. 61, 443.

FIG. 183.



Bulb and parachute snare.

FIG. 184.

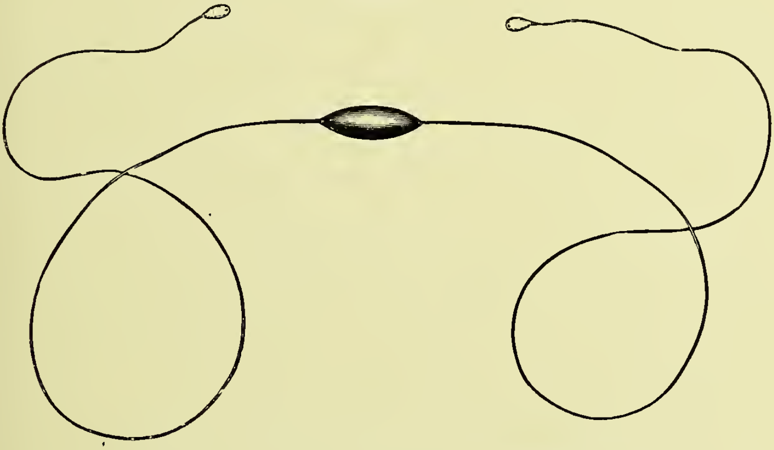


Whalebone sound with adjustable ivory tips.

cause), the symptoms are at first those of an acute œsophagitis: pain, dysphagia, and salivation. Later these symptoms disappear, and the patient seems well and free from discomfort of any kind. This period of calm is succeeded by a gradually increasing difficulty in swallowing until only fluids can be taken. Wasting rapidly follows, and when fluids are no longer swallowed emaciation becomes extreme.

When the stricture is due to the growth of a tumor or the pressure of aneurism, the early irritative symptoms are wanting, and an *x*-ray plate will often reveal the presence of a tumor.

Fig. 185.



Metal bulb to facilitate the sawing of œsophageal stricture.

The **treatment** should be dilatation by means of flexible gum-elastic œsophageal bougies passed every second day until one 40 or 50 mm. in circumference can be introduced, after which the instrument should be passed by the patient at least once a week.

When gradual dilatation is impossible, and especially in those cases in which starvation is rapidly progressing, gastrostomy should be performed and the patient generously fed through the fistulous opening.

When strength returns, a thread should be swallowed, and by this a piece of strong braided silk or fish-line carried through the œsophagus from the mouth downward and out at the gastrostomy wound. With this line the stricture can be "sawed" to any extent, care being taken during the sawing to protect the mucous membrane of the stomach and throat by means of a metal tube for the former and a perforated tongue-spatula for the latter. The presence of a fusiform metal bulb attached to a piece of piano-wire (Fig. 185), held firmly against the stricture during the cutting, keeps the stricture on the stretch and prevents injury to other parts by passing through the stricture as soon as it is sufficiently enlarged. When all strictures are divided in this way to No. 50 of the French scale, a rubber tube of the same size may be drawn through the stricture by means of a piece of heavy silk or twine attached to either end, and left in position for several days. This checks hemorrhage, and if the tube is of full size, introduced while on the stretch and allowed to relax after it is in place, a certain amount of continuous dilatation is maintained. The two ends of the twine attached to the tube should be secured or tied together. If this is not done, full-sized bougies should be passed every second day, either from the mouth or from the gastrostomy wound. The latter method is often necessary owing to the presence of a diverticulum just above the stricture, which engages the end of the bougie passed by the mouth and prevents its passing into the normal opening. Considerable ingenuity has been expended in devising bougies which would pass a stricture without being arrested in the often present diverticulum. For a description of these the reader is referred to the articles of Mixter and Gottstein. When introducing bougies from below, they should be guided by a previously swallowed thread attached to the tip of the bougie by three or four half-hitches. As soon as it is possible for the patient to pass a full-sized bougie from above, the gastrostomy wound should be allowed to heal.

Œsophageal Diverticula.

Œsophageal diverticula may be congenital or acquired. The acquired variety are generally due to stricture, to traction on the tube by neighboring inflammatory processes, or to hernia of the mucous membrane through an abnormally weakened muscular coat from inside pressure.

The **symptoms** of an œsophageal diverticulum are dysphagia, the frequent regurgitation of large amounts of mucus, and the presence of a swelling in the neck during the process of swallowing a meal. In these cases the patients are unable to swallow solid pieces of food, and learn to subsist chiefly on fluids and semisolids, as mush, custard, and scraped beef or finely hashed meat. The first food taken at a meal is swallowed with difficulty and generally passes into the diverticulum, after which swallowing is easier, the food passing over the filled diverticulum into the stomach. An œsophageal bougie passes into the diverticulum when it is empty; when, however, it is filled with food, the bougie may often be introduced into the stomach.

Treatment.—When the diverticulum is situated in the neck, it can be exposed by the ordinary incision for external œsophagotomy, the pouch removed, the œsophageal wound sutured with two or more layers of fine silk or chromicized catgut, and the external wound closed with a rubber tissue drain. In deep thoracic diverticula little can be done until the difficulty in swallowing becomes extreme. In these cases gastrostomy is indicated.

Tumors.

Both benign and malignant tumors occur in the larynx, pharynx, and œsophagus.

Tumors of the Larynx.—The tumors most frequently found in the larynx are papillomata, fibromata, and epitheliomata.

Papillomata occur generally before middle life, and are located on the vocal cords, just below the anterior commissure, or in the pyriform sinus. They appear as pedunculated or sessile, wart-like masses, which show no tendency to infiltrate the surrounding tissues. In adult life they are generally single, in childhood they are often multiple, and may cover the ventricular spaces, vocal cords, and extend into the trachea.

Fibromata may be of the hard or soft variety. They are most frequently encountered on the vocal cords or at the anterior commissure. They are covered by intact mucous membrane and may be pedunculated.

Epitheliomata occur later in life and their malignancy depends largely upon their location. Those situated wholly within the larynx (*intrinsic cancer*), as on the true or false cords in the ventricles or in the subglottic spaces, grow slowly, rarely infect the lymphatics, and almost never give rise to visceral metastasis. Those occurring at the superior aperture of the larynx (*extrinsic cancer*) grow more rapidly, infect the lymph-nodes at an early period, are often spread to the tissues of the pharynx and tongue.

Tumors of the Trachea.—New growths of the trachea are rare. Of the benign growths papillomata and fibromata are the most common. Lipomata, chondromata, and adenomata have been observed. Intratrachial struma or abarrant masses of thyroid tissue also occur in the trachea, chiefly on the posterior wall.

Of the malignant growths, carcinoma and sarcoma are to be considered. The former occurs with greater frequency, the proportion being two to one.

Tumors of the Pharynx and Œsophagus.—*Epithelioma* occurs in the pharynx near the base of the tongue and in the upper part of the œsophagus.

Cancer of the thoracic portion of the œsophagus is apt to be of the glandular variety, and affects chiefly the lower portion of the tube as it passes through the diaphragm.

Sarcomata may occur in the pharynx, very rarely in the larynx or trachea, except by extension from other regions.

Angiomata, lipomata, and *myomata* have been observed.

Diagnosis and Treatment of Tumors of the Larynx.—The *symptoms* of tumor of the larynx are a progressively increasing hoarseness, cough, and dyspnœa. As these symptoms are common to many affections of this organ, the diagnosis can only be established by a laryngoscopic examination. If after laryngoscopic examination doubt exists as to the nature of the growth, a generous fragment should be removed with forceps and subjected to microscopic examination.

Treatment.—Small papillomata of the larynx may often be made to disappear by inhalations of a spray of alcohol (Delavan) or by the application of caustic agents. The best method of treatment is by removal with cutting forceps under guidance of the eye by means of a laryngoscope. This, however, should only be undertaken by a skilled laryngologist. Subglottic tumors are reached and easily removed by median thyrotomy. Epithelioma of the larynx in its earliest stages may often be successfully removed by thyrotomy (Butlin) or by partial laryngectomy. Total laryngectomy is, however, the operation of choice in all cases of malignant disease of the organ in which the cartilage is eroded. In advanced cases it should always be accompanied by extensive *bloc* dissection of the lymphatics and the lymph-bearing areolar tissue of the neck. This method should also be adopted in malignant growths of the superior aperture of the larynx, as in these cases the disease quickly involves the lymphatics and pursues a much more rapid course.

Diagnosis and Treatment of Tumors of the Trachea.—Tracheal tumors rarely give rise to symptoms until stenosis occurs. Dyspnœa is generally the first symptom. Later there is cough with increased dyspnœa and cyanosis on exertion. Papillomata not infrequently develop just above the tracheal opening in patients after tracheotomy, and who for any reason are obliged to retain the tube for a long period of time. The treatment is by an extensive tracheotomy or laryngotracheotomy with removal of the growth if benign. In malignant cases more or less extensive tracheal resections may be necessary.

Diagnosis and Treatment of Tumors of the Pharynx and Œsophagus.—Tumors of the lower pharynx and œsophagus rarely give rise to symptoms until they extend to other organs, as the larynx, or cause obstruction. The first symptom is generally dysphagia, which gradually increases until typical symptoms of stricture are produced. The extension of a pharyngeal growth to the larynx is indicated by dyspnœa and loss of voice. Pain occurs as a later symptom. Benign tumors when accessible sometimes can be removed by lateral or infrahyoid pharyngotomy or by external œsophagotomy. The treatment of malignant tumors of the œsophagus has until quite recently been unsatisfactory. At the last meeting of the International Congress of Surgery (1908), Gluck, of Berlin, exhibited a number of cases of advanced malignant disease of the larynx, pharynx, and œsophagus successfully operated upon by thorough local removal and extensive bloc dissections of the lymphatics of the neck. Carcinoma of the thoracic portion of the œsophagus has not as yet been successfully removed, although by the use of Sauerbruch's negative pressure cabinet surgical approach to this region has been rendered less hazardous.

Tuberculous and Syphilitic Ulcerations.

Tuberculous and syphilitic ulcerations of the larynx are of frequent occurrence. The former begin in the arytenoids or vocal cords, and gradually extend to the other tissues, including the pharynx. The latter begin by a gummatous infiltration of the epiglottis or cords, which soon breaks down, forming typical syphilitic ulcers which extend to the neighboring tissues. Perichondritis and necrosis of the cartilages may occur. Obstinate cicatricial stenosis frequently follows syphilitic ulceration. The treatment is purely medical until stenosis occurs.

OPERATIONS ON THE LARYNX, PHARYNX, AND ŒSOPHAGUS.

Thyrotomy.

This operation is undertaken for the prompt relief of sudden œdema of the glottis or other forms of respiratory obstruction occurring at the rima glottidis. In an emergency it may be performed by plunging the blade of a pocket knife through the lower part of the thyroid cartilage and cricothyroid membrane, and separating the edge of the wound by turning the blade sideways or inserting the handle of the knife, a key, or bent hairpin. Performed in this manner there is always danger of hemorrhage from a branch of the cricothyroid artery.

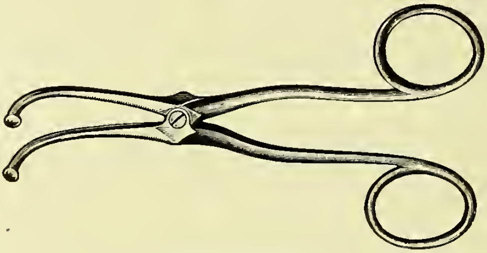
Complete Section of the Thyroid Cartilage.

Complete section of the thyroid cartilage in the median line is employed for examination of the interior of the larynx and for the removal of intralaryngeal growths. The patient should be placed in the Trendelenburg posture and a preliminary tracheotomy performed, with closure of the trachea by means of a sponge inserted above the canula or by the use of a Hahn tube. An incision should then be made in the median line from the hyoid bone to the second or third ring of the trachea, dividing all structures down to the cartilage. The larynx should then be opened, the two halves separated, and the parts inspected. After carrying out the necessary intralaryngeal procedures the cartilages may be brought accurately together and held by several sutures, or the wound packed with sterile gauze. The tracheal tube should be retained until the danger from œdema or hemorrhage has passed.

Tracheotomy.

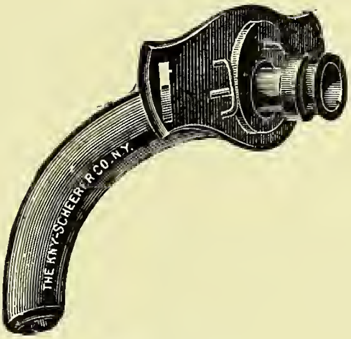
An incision should be made in the median line over the trachea, the sternohyoid and sternothyroid muscles separated by retractors, and the trachea exposed above or below the isthmus of the thyroid. Several large veins are often encountered both above and below the deep fascia, which should be secured and divided between ligatures. When the trachea is cleared, clearly exposing the rings, and when all hemorrhage is arrested, a vertical incision should be made into the tube, the edges of the wound separated by a tracheal dilator (Fig. 186), and a tracheal tube (Fig. 187) introduced and held securely in place by a tape passed around the neck. One or two cutaneous sutures may be inserted or the wound packed with gauze. Following the tracheotomy, patients should be kept in a warm room and the head of the bed surrounded by a tent of blankets to avoid draughts of air (Fig. 190). A croup kettle or steam atomizer is of advantage in some cases to render the inspired air moist and warm. The patient should be carefully watched, the tube regularly cleaned, the wound frequently dressed, and the inspired air at first filtered by passing through several layers of loose gauze wet with hot boric acid solution. There is a fairly high mortality following tracheotomy, from

Fig. 186.



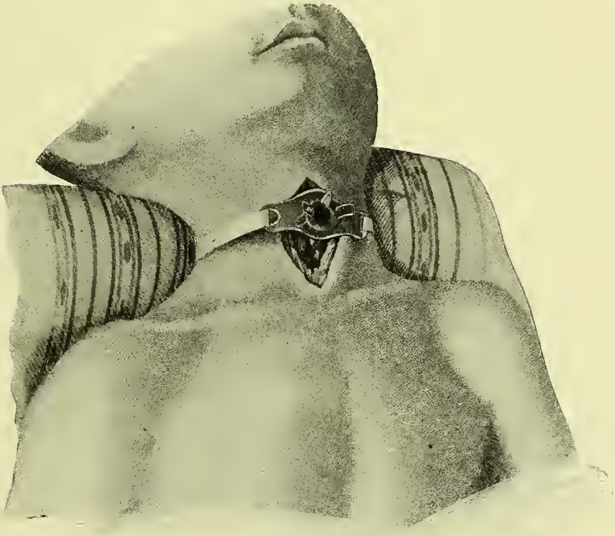
Tracheal dilator.

Fig. 187.



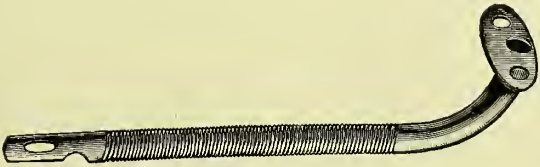
Tracheal tube.

Fig. 188.



Tracheotomy tube in position.

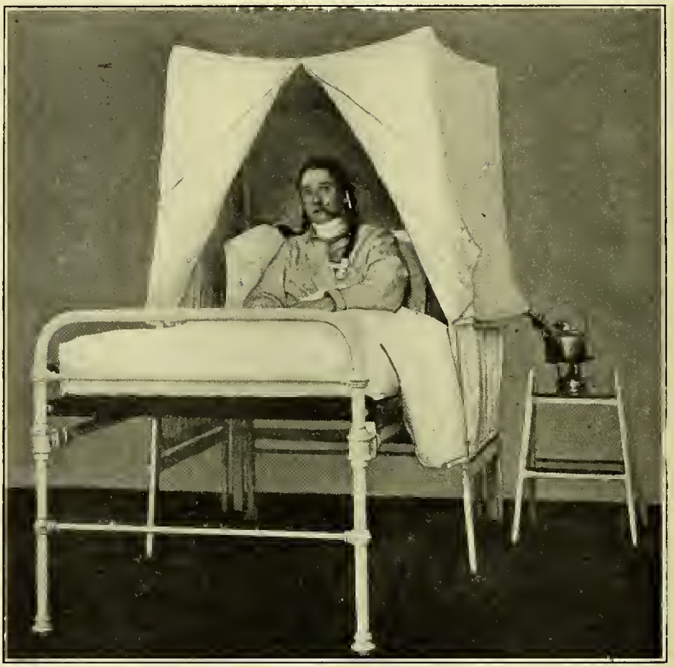
Fig. 189.



König's spiral canula.

the frequent occurrence of septic pneumonia. This should always be considered in performing the operation preliminary to other operations on the upper air passages. The pneumonia in these cases is largely due to the inhalation of blood during the operation and of septic material after recovery from the anæsthetic. Great care should, therefore, be used to avoid both of these dangers.

FIG. 190.

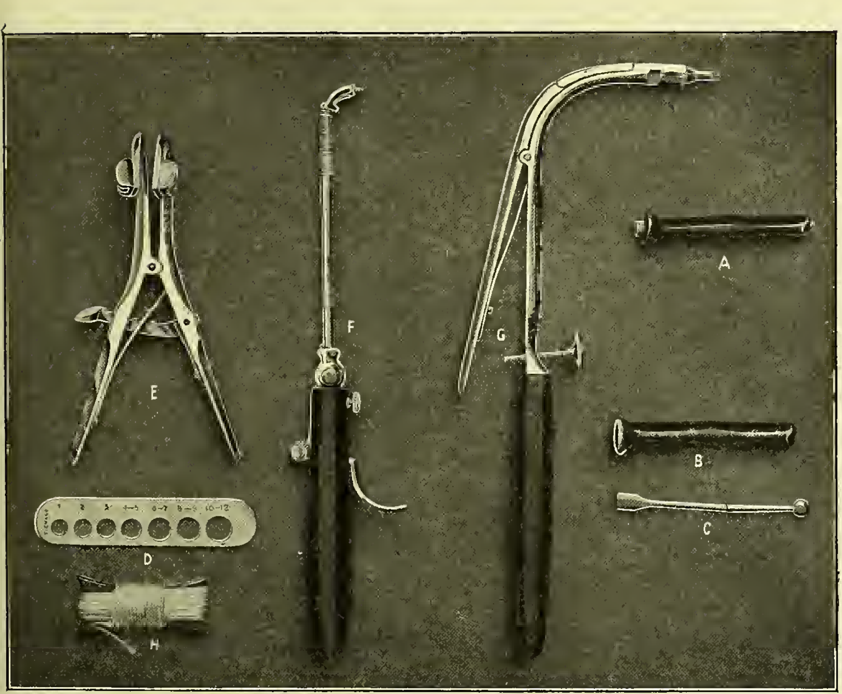


Tracheotomy tent showing patient after total laryngectomy.

Intubation of the Larynx.

This operation consists in the introduction into the larynx of a metal or gutta-percha tube so constructed as to fit its lumen, and provided with a flange on its upper extremity to rest upon the false cords. The operation is performed by a special set of instruments devised by O'Dwyer (Fig. 191). No anæsthetic is required in ordinary cases. The patient sits or is held in front of the operator with the mouth widely open. The surgeon then adjusts the tube to the introducer, passes his left forefinger over the base of the tongue to the epiglottis, which, with the base of the tongue, is drawn well forward. The tube is next passed into the pharynx and the tip directed into the larnygeal entrance by elevating the handle of the introducer. As soon as the tube passes the glottis, it is pushed from the introducer by means of a lever device on the handle, and the tube pressed well downward by the forefinger of the left hand (Figs. 192, 193, 194). In removing the tube, the orifice is located with the finger, the tip of the extractor passed into its opening, the jaws opened, and both tube and extractor removed.

Fig. 191.

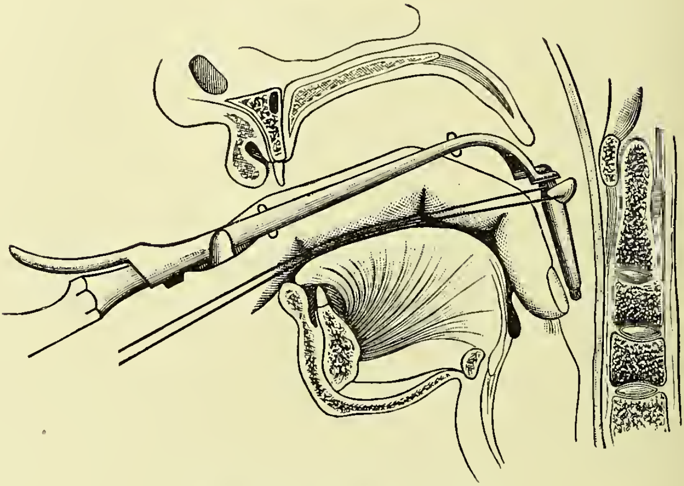


O'Dwyer's intubation instruments: A, Tube with obturator; B, tube; C, obturator; D, metal gauge; E, mouth-gag; F, introducer; G, extractor; H, silk cord. (Fowler.)

Laryngectomy.

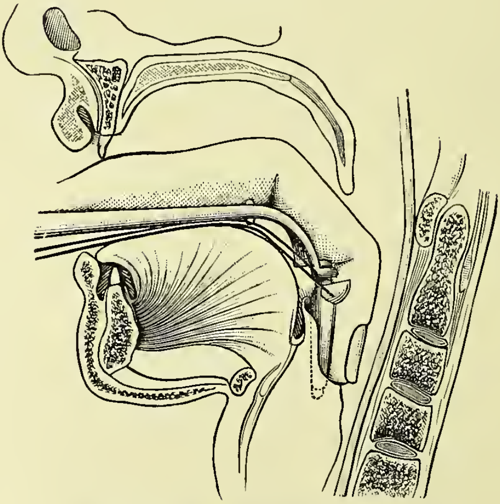
The operation is performed in two stages. Chloroform is employed for anæsthesia. A median incision is made extending from the cricoid to the sternal notch. The muscles are separated, exposing the isthmus of the thyroid, which is double ligated and divided. The separated edges are pushed to each side and the trachea freely exposed. A low tracheotomy is then performed

Fig. 192.



The tube in the pharynx. (Lejars.)

Fig. 193.

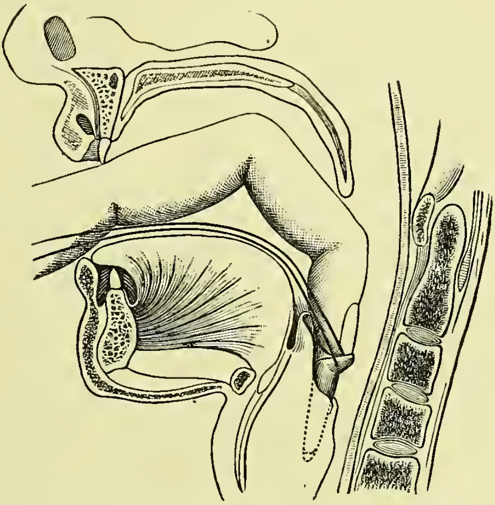


The tube penetrates the larynx. (Lejars.)

and the canula introduced, after which the upper part of the incision is united with silk-worm gut sutures, and the peritracheal space generously packed with iodoform gauze both above and below the canula (Fig. 195). The wound is dressed, and the patient placed under a tracheotomy tent (Fig. 190), into which a small amount of steam is introduced by means of a croup kettle. The external opening of the tracheal canula is constantly covered with four or five layers of gauze wet in warm boric acid solution with a view to filtering the air which enters the trachea. A special day and night nurse attends the patient.

About ten days after the preliminary operation, if the patient has a normal temperature and is not suffering from cough or excessive tracheal secretion, the secondary operation is undertaken. Chloroform is administered through the tube until the patient is anæsthetized, after which its administration is continued in the same manner, or colonic etherization is employed by means of the Sutton apparatus.

Fig. 194.

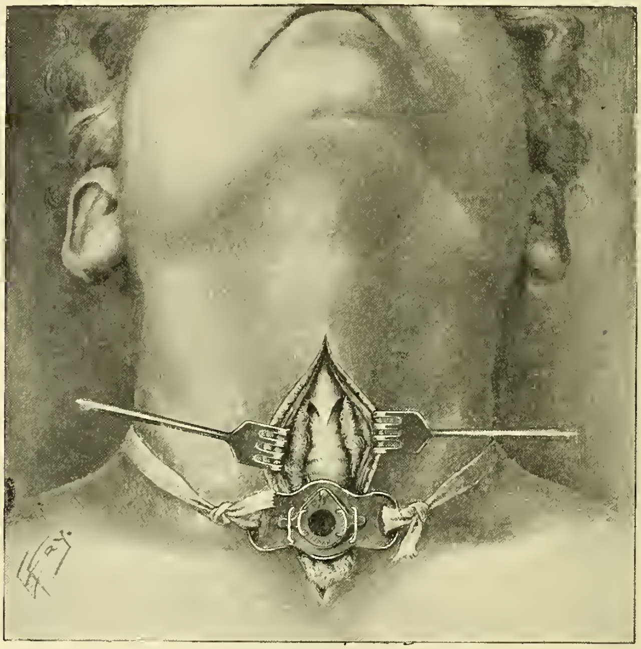


The finger pushes the tube into place. (Lejars.)

The use of scopolamine (gr. $\frac{1}{100}$) and of morphine (gr. $\frac{1}{6}$) one-half hour before operation is a decided advantage in these cases, as it not only diminishes to a considerable extent the amount of anæsthetic required, but in addition it minimizes tracheal secretion, lessens the postoperative vomiting, and insures a period of from one to four hours of freedom from restlessness after the operation, a time when most laryngeal cases are coughing, and increasing thereby the always present tracheal irritation.

The patient is placed on a flat table with the head well extended. An incision is made from the body of the hyoid downward to the upper limit of the former cut. From the upper extremity of this incision two lateral incisions are made in an upward and outward direction, extending to the anterior borders of the sternomastoid muscles. The two triangular flaps are turned outward, the sternohyoid muscles divided just below their attachment, and the sternothyroids detached from the cartilage (Fig. 196). The two superior thyroid arteries are next located and ligated. The superior laryngeal nerves are cut and all lymph-nodes and neighboring lymph-bearing areolar tissues are removed. The attachments of the inferior constrictors are next divided and the posterior surface of the cricoid partly separated from the œsophagus by blunt dissection.

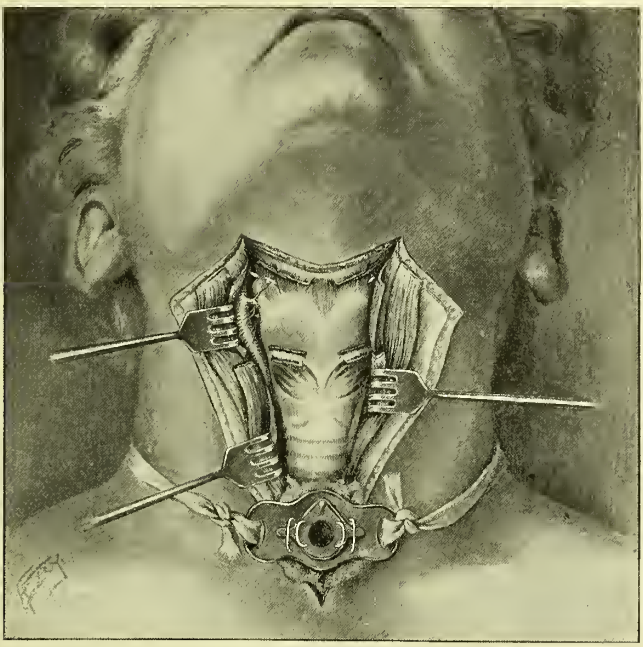
Fig. 195.



Preliminary tracheotomy with gauze packing about trachea.

When the larynx is thoroughly skeletonized, the trachea is severed just below the cricoid, and its distal extremity immediately packed tightly with gauze, completely preventing the entrance of blood or pharyngeal mucus. The forefinger of the left hand is next introduced into the upper or laryngeal segment of the tube and the larynx gently raised from the œsophagus, any remaining attachments being separated by gauze sponges (Fig. 197). When the larynx is thus completely separated from the œsophagus, the tips of the thyroid cornua are divided, the thyrohyoid membrane incised, and the larynx removed. The pharyngeal wound is then packed with gauze to prevent excessive contamination of the wound, and the parts carefully inspected for evidences of remaining disease. The oval pharyngeal wound is next tightly closed by two layers of suture, the first of plain catgut, the second of chromic catgut (Fig. 198). After closure of the pharyngeal opening, the entire upper wound is temporarily packed with wet formalin gauze, while the tracheal stump is prepared for closure. This is accomplished by removing redundant tissue above the canula opening, dissecting out or destroying with cautery the

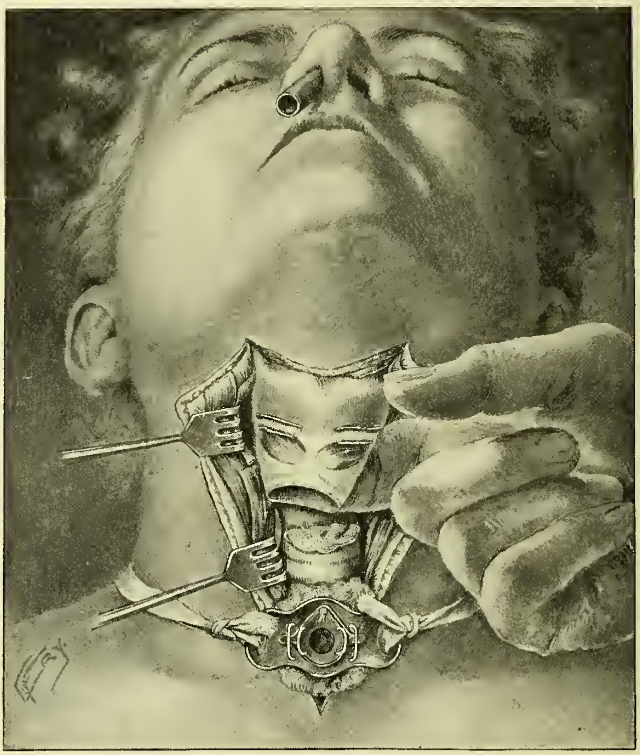
Fig. 196.



Exposure of larynx.

mucous membrane, and packing firmly with iodoform gauze above the tube. A No. 30 F. rubber feeding tube is then introduced through the nostril into the œsophagus and secured by a safety pin and plaster straps to the face. The wounds are next united above, with generous gauze packing about the tracheal canula (Fig. 199). Water is given through the tube as early as the morning following the operation if there is no nausea. Milk, coffee, egg-nog, meat juice, and soups follow as soon as possible. No attempt at swallowing should be made for at least seven days, after which the tube can be removed. The wound should be dressed at least once every day, and two or three times if there is infection or pharyngeal leakage.

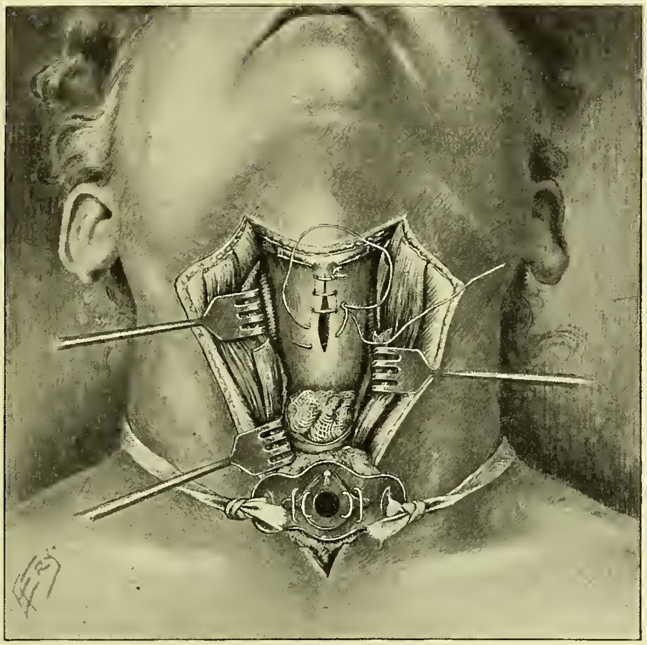
Fig. 197.



Section of trachea with packing of distal extremity.

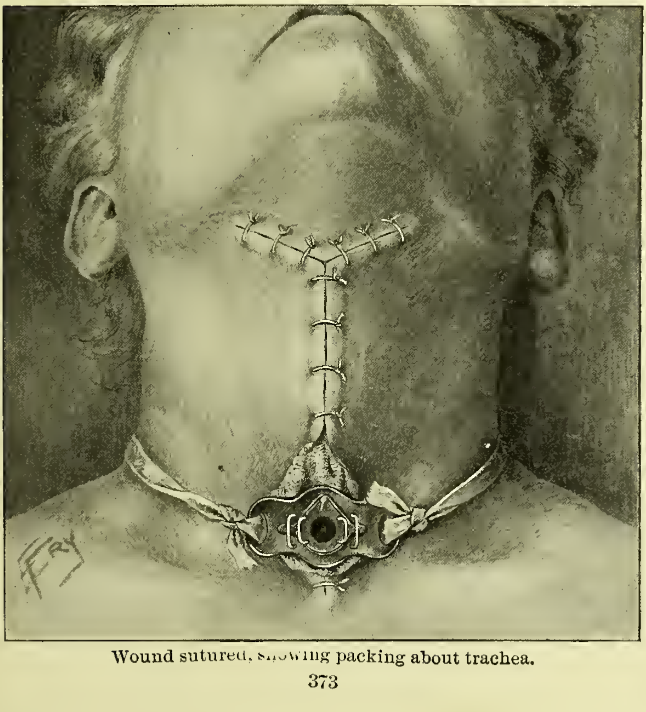
The tracheal stump is quickly covered with granulations and gives no trouble. The patients continue with the silver canula.

Fig. 198.



Section of pharyngeal wound and preparation of tracheal stump.

Fig. 199.



Wound sutured, showing packing about trachea.

The after-treatment should be the same as that following tracheotomy. Patients should be encouraged to assume a sitting posture as soon as possible after operation. In the earliest stage of intrinsic cancer of the larynx, extensive dissection of the neck is not necessary, as the lymphatics are rarely involved. At a later period, however, and in all cases of extrinsic growth, a thorough removal of all nodes and lymph-bearing areolar tissue is imperative.

Subhyoid Pharyngotomy.

Subhyoid pharyngotomy is occasionally useful for the removal of a small growth in the upper larynx. A transverse incision should be made just below the hyoid bone and the thyrohyoid membrane exposed. When all bleeding is arrested, this should be incised, the epiglottis drawn outward or excised, and the necessary procedures carried out, after which the wound should be closed with subcutaneous drainage.

External Œsophagotomy.

An incision is made along the anterior border of the left sternomastoid muscle from a point opposite the upper margin of the thyroid cartilage to the sternoclavicular articulation, dividing the skin, superficial fascia, and platysma. The omohyoid muscle is retracted and the tissues separated by blunt dissection until the great vessels are reached. These are carefully retracted outward, the thyroid gland and overlying muscles retracted inward, and the lateral wall of the trachea and œsophagus exposed. The recurrent laryngeal nerve should be found in the groove between these two structures and held aside. An œsophageal bougie is next introduced from the mouth and the œsophagus opened upon it as a guide. After the necessary procedures have been carried out, the œsophageal wound should be tightly closed with two layers of fine silk or chromicized catgut and the superficial structures united by layer suture.

DISEASES OF THE EAR.

Deformities.

The external ear may be notched, the pinna may be absent, or the entire ear may project abnormally, giving rise to an unsightly appearance. These deformities may be corrected by plastic operations.

Furuncles.

Furuncles occur with great frequency in the external auditory canal, and cause much annoyance by the pain, tenderness, and swelling of the parts. They occur usually in crops; as many as ten or twelve may appear in an individual in as many weeks. They should be promptly incised and the ear frequently irrigated with carbolic acid solution (1 : 100). As in cases of furunculosis elsewhere, an effort should be made to increase the resistance of the individual by tonics, fresh air, exercise, and raising the opsonic index by the hypodermic injection of vaccines.

Hæmatoma.

Hæmatoma of the external ear occurs in the insane and as a result of trauma. The lesion is a subperichondrial hemorrhage which frequently causes great thickening of the tissues and a deformity which never fully disappears. As a rule, no treatment is required. Occasionally when the bleeding occurs on the posterior aspect of the cartilage, incision and removal of the clots may be indicated if the case is seen sufficiently early.

Otitis Media.

Otitis media is an acute inflammation of the mucous membrane lining the cavity of the tympanum, usually caused by an ascending infection through the Eustachian tube.

The **symptoms** are pain in the ear, deafness, fever, and a rapid, full pulse. The pain is severe and often of a lancinating character. On examination, the drum-membrane will be found reddened and bulged outward. This disease is of interest to the surgeon chiefly on account of its complications. If untreated, acute otitis media may be spontaneously relieved by rupture of the drum-membrane and evacuation of the pus. If considerable pressure exists from an accumulation of pus or septic fluid, the infection may spread to the *mastoid antrum*, giving rise to pain and tenderness behind the ear, with redness and œdema of the skin and subcutaneous tissues. If this condition is not promptly relieved by operation, the infection may extend to the neighboring mastoid cells, causing a more or less extensive osteomyelitis, which not infrequently involves the lateral sinus, causing septic thrombosis, pyæmia, and death; or to the meninges or brain, giving rise to septic meningitis, cerebritis, or brain abscess. These latter complications are often the result of an acute exacerbation of an old subacute otitis media, the only symptom of which may be the presence of chronic otorrhœa.

The **treatment** of acute otitis media should be prompt incision of the drum and the relief of tension. The incision should be made in the lower posterior quadrant of the membrane, and should be followed by frequent irrigations with a warm solution of boric acid. Early incision, during the first few hours of the pain, when the cavity is filled simply with clear serum, will often abort the process. The relief to the pain is immediate and the opening in the drum heals perfectly in a few days.

The **treatment of mastoiditis** should be equally prompt to avoid extension of the disease to the brain or lateral sinus. An incision should be made behind the ear from a point three-quarters of an inch above the meatus downward to the tip of the process. The incision is carried to the bone and the periosteum and soft parts retracted. An opening is then made by a small chisel or gouge into the mastoid antrum, which lies in the *suprameatal triangle*, a space bounded by the upper posterior margin of the bony canal, and two lines drawn tangent to the roof and posterior wall of the bony meatus. The antrum lies about three-fifths of an inch below the surface. In the early cases all that will be required is a free opening into the antrum, with disinfection and packing with gauze. If the disease has spread to the other cells of the mastoid process, it may be necessary to expose and open them down to the tip of the process.

The treatment of sinus thrombosis and of the cerebral complications of the disease has been considered in Chapter XIII.

CHAPTER XVI.

INJURIES AND DISEASES OF THE THORAX, PLEURA, AND LUNG.

Contusions.

Contusions of the chest-wall are of frequent occurrence, and are only important on account of the complicating visceral injuries which may be associated with them.

In the majority of instances severe contusions of the chest are accompanied by fracture of one or more ribs, the diagnosis and treatment of which will be considered in Chapter XXVII.

Rupture of the parietal or visceral layer of the pleura, injury of the lung, and injuries of the pericardium and heart, may occur from severe blows or contusions of the chest without fracture or external wounds. Fatal shock has also been observed without apparent visceral injury.

Injuries of the pleura are indicated by pain which is increased by deep inspiration, and by the presence of a friction-sound over the seat of injury. Rupture of the lung is indicated by cough, bloody expectoration, and the evidences of hæmothorax and pneumothorax. Exceptionally no signs of visceral injury are apparent at the first examination. Subpleural injury of the lung may occur, and, in addition to the cough and bloody expectoration, may cause a subpleural emphysema which travels upward to the root of the lung through the mediastinal areolar tissue to the root of the neck, and from there may spread in any direction. The diaphragm is occasionally ruptured by a severe contusion or crush of the chest-wall, and, in some instances, a hernia of the stomach or other of the abdominal viscera may take place into the pleural cavity. Blows over the lower left chest often produce alarming symptoms of shock, which sometimes is fatal.

Treatment.—The treatment of uncomplicated contusions of the chest calls for nothing other than rest and limiting the respiratory movements. This is accomplished best by a firm binder or adhesive plaster strips. If rupture of the lung is present, strapping the chest will limit the respiratory movements and give relief if the hemorrhage is not progressive. Absolute rest should be enjoined, and, if the symptoms of progressive hemorrhage are present, threatening life, the chest should be opened and an effort made to find and secure the bleeding point. It not infrequently happens that a thoracotomy which allows air to enter the pleural cavity will cause the arrest of hemorrhage by collapse of the lung.

Wounds of the Chest-wall.

Wounds of the chest-wall may be penetrating or non-penetrating. The former are generally caused by severe compound fractures or by gunshot or stab wounds. If the wound is of sufficient size to admit air to the pleural cavity, *pneumothorax* results, which is indicated by cough, dyspnœa, rapid respiration, the absence of respiratory sounds over the affected side, and the presence of an abnormal tympanitic resonance.

In stab wounds of the chest with hemorrhage from a vessel of the chest-wall, the blood is often aspirated into the pleural cavity by the respiratory efforts, little or none escaping at the surface of the wound.

In gunshot wounds of the thorax, those made by the modern small-calibre high-velocity weapons produce, as a rule, much less damage than those made by the older large-calibre arms. In the former there is less splintering of bone, less laceration of lung tissue, and, consequently, less hemorrhage and sepsis.

If the lung is wounded, cough will be present and will be accompanied by bloody expectoration. If bleeding occurs into the pleural sac, either from a wound in the lung or from an injured vessel in the chest-wall, *hæmothorax* will be produced, indicated by the presence of flatness over the lower part of the chest with absence of fremitus and of the normal respiratory sounds. If the bleeding is considerable, it may fill the greater part of the pleural sac and give rise to all the signs and symptoms of concealed hemorrhage. Subcutaneous emphysema is a frequent symptom of wounds of the chest. Non-penetrating wounds of the chest-wall present no special features.

Treatment.—If there is reason to believe that a penetrating wound in the chest is free from infection, and there is no evidence of an alarming hemorrhage, the treatment should be by rest, the application of a chest-binder, and an antiseptic dressing to the external wound. Probing the wound is dangerous, and, as a rule, furnishes no valuable information. Air in the pleural cavity is quickly absorbed if the wound of entrance is sealed. Free blood in the pleural cavity quickly clots, and if sterile absorbs readily. The presence of blood and air from an *external* wound in the pleural cavity usually results in infection and empyema. Blood in the pleural cavity with air from a wound in the *lung* without external contamination generally remains sterile, and eventually is absorbed. If there is reason to believe that a penetrating wound of the chest is infected, it should be explored, enlarged if necessary, all hemorrhage arrested, any foreign body removed, and the pleural cavity drained with gauze or rubber tube.

In the presence of a progressively increasing hæmothorax, the wound into the pleural cavity should be enlarged by the removal of one or more rib segments, the clots removed, the source of the hemorrhage located and treated if possible by ligation or the suture-ligature. If this is impossible, gauze packing may be employed with pressure at or near the bleeding point.

Abscess of the Chest-wall.

Abscesses of the chest-wall differ in no way from abscesses in other parts of the body, excepting those which occur under the pectoral muscle and those which occur in the axilla.

Subpectoral abscess results from a cellulitis beneath the pectoral muscles, which may arise from a neighboring wound, from lymphatic infection, from disease of the bone, or as a part of some general septic disease. The symptoms may be misleading at first, but localized pain is generally present, and is greatly increased on attempting to raise the arm above the head. Fluctuation is often obscured by the overlying muscle. The treatment should be by free incisions and drainage.

Axillary abscess is generally the result of infection of the axillary lymph-nodes. The suppuration may be extensive and burrow deeply in the axilla around the great vessels and nerve-trunks. The treatment should consist in freely opening the axilla, with removal of the pus and diseased glands. This can only be accomplished by a generous incision, a good light, and ample retraction of the wound edges. The knife should be sparingly used, and after the first incision is made removal of the diseased glands may be accomplished largely by the finger or blunt dissection.

Osteomyelitis of the Ribs.

Osteomyelitis of the ribs or sternum may occur, and give rise to abscesses with more or less extensive necrosis of the bones. Acute septic osteomyelitis is rarer than the typhoid, syphilitic, or tuberculous variety. It is apt to occur in the rib near the chondral junction. The process at first involves the medullary cavity, finally erodes the cortex, and produces a subperiosteal abscess, which in turn may rupture on the surface or, rarely, within the pleura. In typhoid osteomyelitis the process is subacute, as a rule, and the bone focus much more limited in extent. In the tuberculous variety the entire course of the disease may be painless, the first indication being the presence of an oblong, fluctuating swelling over the rib without heat or redness.

In the acute septic variety there is, as a rule, severe boring pain, with œdema and redness of the overlying soft parts, fever, and evidences of toxæmia.

Treatment.—In the treatment of the septic variety of osteomyelitis of the ribs or sternum early incision through the periosteum will often give marked relief and limit, to a considerable extent, the destruction of bone. In all, thorough removal of the bone focus is essential, followed in the tuberculous cases by curetting and packing with iodoform or formalin gauze.

Tumors of the Chest-wall.

Tumors of the chest-wall are conveniently divided into those arising from the soft parts and those taking their origin from the bony framework. Of the former may be mentioned *fibroma* and *fibroma molluscum, lipoma, sarcoma: sebaceous, dermoid,* or *echinococcus cysts;* of the latter, *osteoma, chondroma,* and *sarcoma* are the most important.

The tumors of the soft parts differ in no respect from similar tumors developing in other parts of the body which have already been sufficiently considered.

Osteomata are most frequently found growing from the ribs at or near their junction with the costal cartilages. In the majority of instances they represent ossified chondromata.

Chondromata are found less frequently in the sternum than in the ribs, and in either situation are generally near a joint. They so frequently degenerate into sarcoma that Quenu and Longuet advise the same radical removal as for sarcoma.

Sarcoma is, undoubtedly, the most frequently observed tumor of the bony thorax. It occurs as a central or peripheral pure growth or as a mixed tumor (osteo-chondro- or myxo-sarcoma). A rare and exceedingly soft pulsating *endothelioma* of bone is occasionally observed in this locality.

Prognosis.—The prognosis in sarcoma of the thoracic wall is exceedingly grave, as only the most thorough removal at an early date will give hope of a radical cure.

Treatment.—In chondroma of the ribs or sternum wide excision is to be advised in the early stage. In sarcoma and in recurrent or advanced chondroma of the ribs, complete resection of the chest-wall is the operation of choice, for the reason that the involvement of the pleura takes place at an early period. In sarcoma of the sternum extensive operation is demanded, but is a formidable procedure on account of the danger of wounding important mediastinal structures.

Pneumothorax.

This is a condition characterized by the presence of air in the pleural cavity.

It may arise from an external wound, from rupture of the lung, or, rarely, from infection by a gas-producing micro-organism. The effect of a pneumothorax unassociated with an external wound (*closed pneumothorax*) is only a moderate interference with respiration noticed on unusual exertion.

Where there is an open pleural wound (*open pneumothorax*) the dyspnœa is more marked, due not only to collapse of the effected lung, but to the absence of the piston action of the diaphragm.

Symptoms.—The symptoms of open pneumothorax are dyspnœa and cyanosis on exertion, cough, rapid heart action, and extreme discomfort. If the opposite lung is diseased, all of these symptoms are exaggerated. Double pneumothorax is generally fatal.

Treatment.—In spontaneous pneumothorax from the rupture of a tuberculous cavity no operative treatment is required, as the gradual collapse of the lung, from the accumulated air and the associated serous effusion, favors closure of the pulmonary opening. At a later period the fluid may be gradually removed by aspiration.

In open pneumothorax, if uninfected, closure of the thoracic wound gives prompt relief by restoring the piston action of the diaphragm. If the pleura is infected, drainage must be instituted.

Removal of the air by aspiration from a closed pneumothorax with disease of the other lung, will often give a large measure of relief.

Hydrothorax.

Hydrothorax is an effusion of serum into the pleural sac. This affection is caused by pleuritis or pneumonia, by wounds of the pleura or lung, by foreign bodies, new growths, or by tuberculosis. It occurs also as a bilateral affection in chronic renal or cardiac disease and in general sepsis.

Symptoms.—The symptoms are a gradually increasing shortness of breath on exertion and cough. The signs are a diminished area of resonance and respiratory murmur, flatness, absence of fremitus, and ægophony.

Treatment.—The treatment should consist in the administration of cathartics and diuretics. Removal of the fluid by aspiration is to be recommended if absorption is slow or fails to occur.

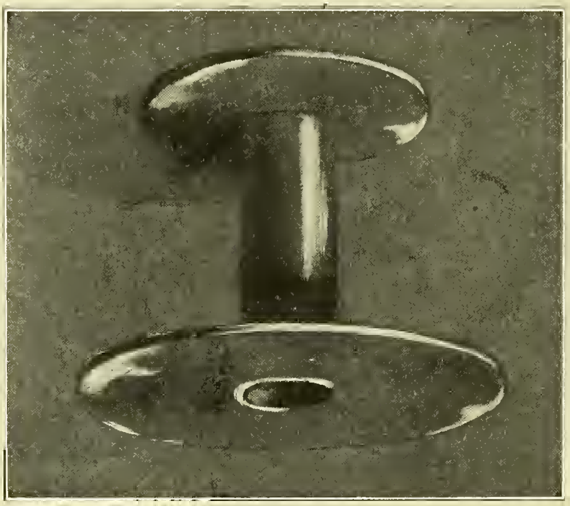
Chylothorax.

The presence of chyle in the pleural cavity is due to rupture of the thoracic duct, generally the result of a fracture of the spine or crush of the chest. The diagnosis is made by an exploring needle. Repeated aspirations have in some cases resulted in a cure of the condition.

Pyothorax, Empyema.

Pyothorax, or empyema, is a collection of pus in the pleural sac. This occurs as a result of infection of a pre-existing pleuritic effusion, or may arise immediately as a result of a penetrating wound of the thorax, or from rupture into the pleura of an abscess of the lung, chest-wall, liver, or subphrenic region. It may arise also from lymphatic extension from an abdominal focus. In certain cases the process is distinctly localized and is shut off from the general pleural cavity by adhesions. In other rare instances such a collection of pus may be situated between the lobes. This variety cannot be differentiated from abscesses in the lung-tissue. In the great majority of cases empyema follows pneumonia. When due to the pneumococcus the pus is thick and creamy in

Fig. 200.

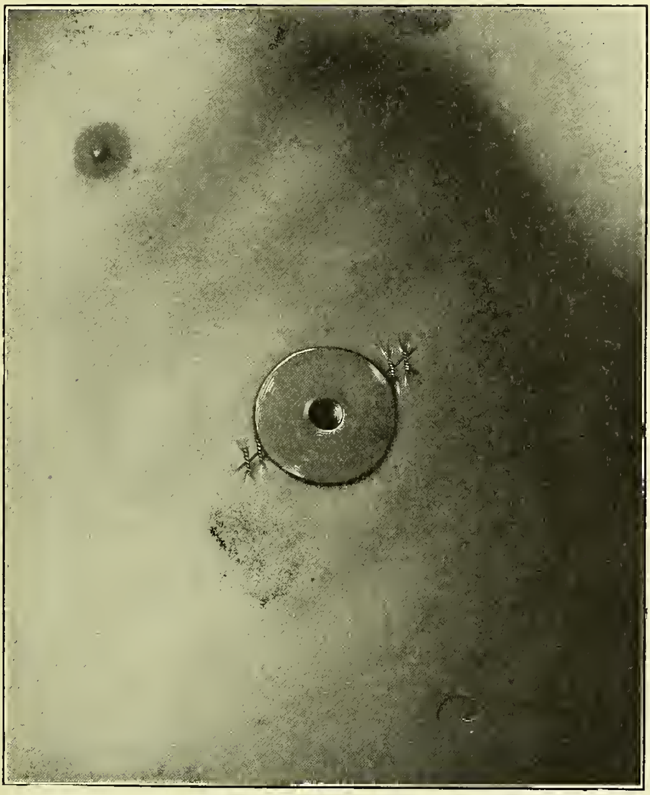


Wilson's empyema drainage-tube.

appearance and the prognosis is favorable. When due to grip infection, to the streptococcus, staphylococcus, or colon bacillus, the pus is thin and watery, frequently contains flakes of fibrin, and may have a foul odor. In these cases the prognosis is more grave. In all cases the parietal and visceral pleura are thickened and covered with a fibrinous exudate.

Symptoms.—The symptoms of empyema often are obscure in the early stages, and the case not infrequently is regarded as one of delayed resolution of a pneumonia. Sooner or later, however, there will be more or less dyspnœa, cough, fever, chills, sweats, a high leucocytosis, and evidences of grave toxæmia.

Fig. 201.



Wilson's empyema drainage-tube in position. (Brewer in "Keen's Surgery.")

The signs are those of fluid in the chest, with displacement of the heart and other mediastinal viscera. In many cases a positive diagnosis can only be made by an aspirating syringe.

Treatment.—In all cases of non-tuberculous empyema the treatment should consist in early evacuation of the pus and the establishment of adequate drainage. Thoracotomy with the resection of one or more ribs and the introduction of a Wilson double-flanged drainage-tube (Figs. 200 and 201) constitutes the best treatment. In adults the operation can be performed with cocaine. In children, as a rule, it is better to give a small amount of ether. Continuous suction drainage by means of a Pollitzer bag attached to the drainage-tube, as recommended by Bryant (Fig. 202), or by hydrostatic pressure by means of two Wolff bottles (Fig. 203) shortens the duration of convalescence.

In old neglected empyemas, where the lung will not expand to fill the pleural cavity, one of three methods may be employed: First, the use of the pneumatic cabinet to forcibly expand the lung; second, removal of the fibrinous envelope which encloses the lung and prevents expansion, and, third, plastic operation on the chest-wall to enable it to collapse on the contracted lung.

The treatment of tuberculous empyema is to avoid open operation until the pus points on the chest-wall, and by hygiene, fresh air, good food, and tonics to improve the normal resistance of the patient.

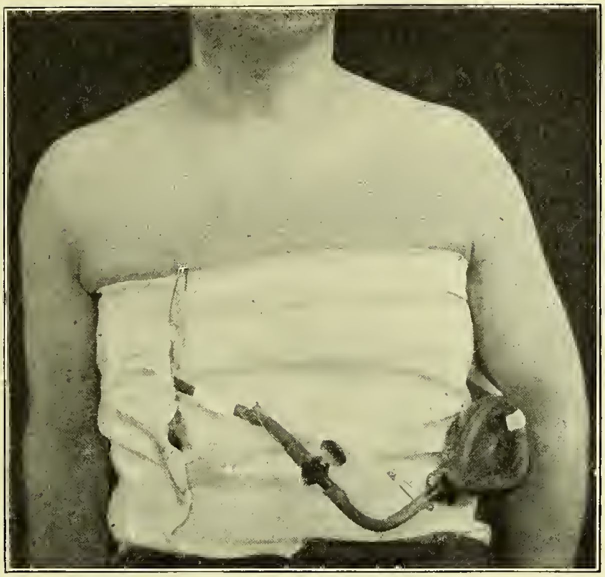
The treatment of the interlobar empyema is the same as for abscess of the lung.

Abscess of the Lung.

This condition is comparatively rare. It occurs as a sequel of lobar pneumonia, in which case the abscess is generally single; as a result of septic bronchopneumonia, in which case the abscesses may be numerous and scattered throughout both lungs; as a result of tuberculosis, foreign body, bronchiectasis, or pyæmia. It has recently been shown that the pneumonias due to influenza are more frequently complicated with abscess of the lung than the ordinary variety.

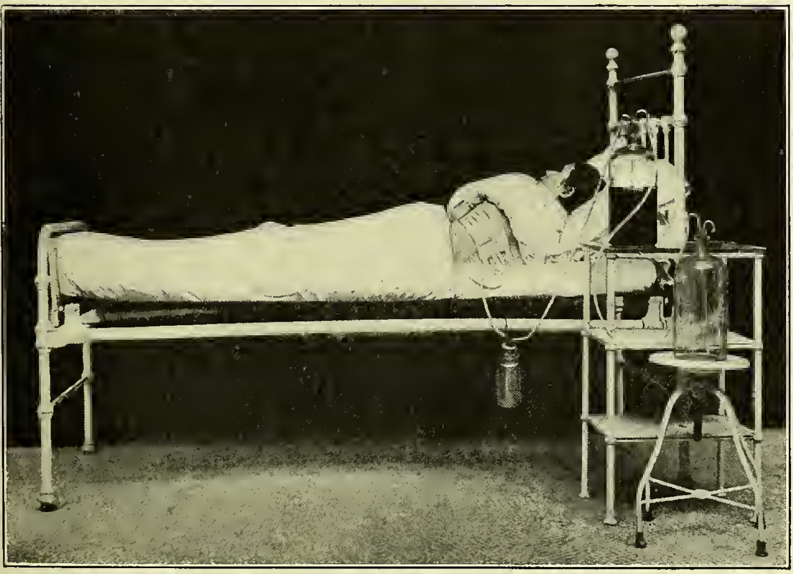
The **symptoms** of abscess of the lung are often obscure. If, following a lobar pneumonia, resolution is delayed and the pulse and temperature remain high, chills, sweats, and progressive asthenia develop, abscess is to be suspected. The signs are those of a limited area of consolidation. According to Tuffier's statistics, abscess of the lung is found more frequently in the lower than the upper lobe, and, as a rule, nearer the posterior surface. As the physical signs frequently are misleading, a positive diagnosis is often delayed until the patient is prostrated by prolonged toxæmia. In the writer's experience the *x*-rays are often of great service in locating a focus. Exploratory aspiration often is necessary to establish the diagnosis.

Fig. 202.



Bryant's empyema drainage.

Fig. 203.



Continuous suction drainage by siphonage.

If the abscess breaks into one of the bronchi there will be abundant expectoration of exceedingly foul-smelling pus.

Treatment.—The treatment of abscess of the lung is by incision and drainage. An incision is made over a rib, the soft parts retracted, and the intercostal muscle divided, exposing the parietal layer of the pleura. If an adhesion exists between the parietal pleura and lung, the former will appear opaque; if no adhesion is present, the pleura will be translucent and the mottled lung will be seen to move beneath it (Keen). If adhesions are present, a director may be gently introduced into the lung, and when pus is reached the opening may be enlarged by passing a closed pair of dressing-forceps along the groove of the director and withdrawing them partly opened. The finger may then be passed into the wound and the cavity explored. A drainage-tube should be introduced and supported by gauze packing. A heavy gauze and cotton dressing should be applied and the wound dressed as infrequently as possible.

If there is no adhesion between the layers of the pleura and the symptoms are not urgent, packing the wound for forty-eight hours will result in adhesions forming, leaving a space through which the abscess subsequently may be opened as above. If the symptoms do not warrant such delay, the pus should be evacuated at once and provision made for drainage of the pleural cavity, which is sure to become infected. In cases where the abscess ruptures into a bronchus without relief of symptoms, the question of external drainage should be considered. In these cases, which often pursue an exceedingly chronic course, Murphy believes the cause of delayed resolution to be the presence of adhesions which prevent collapse of the lung and its contained cavity. For this he advises thoracotomy, the introduction of the hand into the pleural cavity, separation of the adhesions, allowing collapse of the lung. Where no adhesions exist he recommends the production of an artificial pneumothorax by the introduction of sterile nitrogen gas into the pleural cavity.

Prognosis.—The prognosis in abscess of the lung is always grave. Single abscesses treated in the manner just described frequently recover. In cases of multiple abscesses of metastatic origin surgical procedures are contraindicated.

Bronchiectasis.

Dilatation of the bronchi is of frequent occurrence in patients suffering from chronic cough. In the majority of instances the dilatations are fusiform, multiple, and associated with an abundant putrid secretion. These cases are not to be subjected to surgical treatment. In certain rare instances there exists a sacculated dilatation which communicates with the bronchus by a narrow opening. These cases strongly resemble chronic abscess of the lung, and often may be relieved by surgical treatment.

Symptoms.—The symptoms of a sacculated bronchiectasis are: Morning cough, with expectoration of a large amount of extremely fetid pus, followed by a period of rest until the cavity refills. With this there is a loss of appetite and strength, a foul breath, more or less emaciation, and evidences of slowly progressing sepsis. The physical signs are those of a cavity when the sac is empty, of an area of consolidation when full. The x-rays are often of value in locating the focus.

Treatment.—The treatment should be the same as for abscess of the lung which has ruptured. In this connection it may be mentioned in certain obstinate cases some authorities advise freely opening the pleural cavity, accurately locating the lesion by palpation, separating all adhesions, and draining both pulmonary focus and the pleural cavity.

Gangrene of the Lung.

Pulmonary gangrene may arise from the same causes as abscess of the lung. It occurs generally in greatly debilitated subjects, and is often associated with diabetes, nephritis, alcoholism, and starvation. In the majority of cases it follows pneumonia. In rare instances it may be the result of pulmonary embolism.

Symptoms.—The symptoms of gangrene of the lung are an exceedingly foul odor to the breath, followed by the expectoration of a large amount of dark-colored material, which, if allowed to stand in a glass, will appear frothy on top and contain at the bottom of the glass shreds and masses of gangrenous tissue. Added to this, there is extreme prostration, often with a subnormal temperature and a rapid, thready pulse. In other cases the temperature may be elevated. Hemorrhages may occur, and in some instances be the immediate cause of death.

Prognosis.—The prognosis in gangrene of the lung is exceedingly grave. Prior to the employment of surgical measures the mortality was upward of 80 per cent. In cases treated surgically the death-rate is between 30 and 40 per cent.

Treatment.—The treatment should consist in freely opening the pleural cavity, locating the area of necrosis, and establishing drainage by generous gauze-packing until the slough separates spontaneously, after which it should be removed and free drainage maintained for the infected pleural cavity.

Actinomycosis of the Lung.

While the primary lesions of actinomycosis occur most frequently in the digestive tract, occasionally they are seen in the lungs as a result of aspiration of the ray fungus. Secondary pulmonary lesions, however, are far more frequently the result of an extension of the disease from some abdominal focus.

The disease in the lung gives rise to areas of consolidation resembling tuberculosis. Later these break down, forming cavities with an excessive formation of granulation-tissue. The pleura and chest-wall are finally invaded with the formation of large areas of brawny induration of the skin and sinuses. As a result of adhesions and contraction of the abundant granulation tissue, retraction of the chest-wall takes place, often with marked deformity.

Symptoms.—The symptoms of pulmonary actinomycosis develop slowly. There are pain, cough, moderate fever, and loss of weight and strength. The physical signs at first are similar to those of tuberculosis. The diagnosis can only be established by observing the small yellow masses in the discharges, which upon microscopic examination reveal the ray fungus.

Treatment.—The treatment should consist in opening and draining pus cavities and the administration of potassium iodide or the copper salts. If the diagnosis of a small primary focus could be established early, radical removal by pneumectomy would be the rational treatment.

Tuberculosis of the Lung.

The surgical treatment of tuberculosis of the lung has recently been revived, and is receiving serious attention. The idea of completely removing a small isolated focus by resection of a portion of the lung-tissue is no longer advocated by surgeons, for the reason that the mortality of such a procedure is high, and the results no better than those which can be obtained by the open-air treatment in incipient cases.

The idea of causing a collapse of the lung which is the seat of a tuberculous lesion seems to be more rational. Some time ago Murphy reported a series of cases in which considerable benefit was obtained by producing an artificial pneumothorax by the introduction of sterile nitrogen gas into the pleural cavity.

Garre, Quincke, and others have advised the removal of several ribs over a tuberculous focus to allow collapse of the soft tissues, and to promote thereby a shrinkage in the volume of the lung and obliteration of the cavity. Many of these operations have been followed by encouraging results.

Friedrich, of Marburg, has recently advised far more extensive resections, allowing complete collapse of the lung on one side. His operation consists in raising an enormous musculocutaneous flap from below upward, exposing the ribs from the second to the tenth. These are next resected from their cartilage to the spine, the posterior layer of periosteum being left adherent to the intact pleura. This procedure results in the immediate complete collapse of the lung. The large flap is then replaced and sutured, and an aseptic dressing applied.

While this formidable operation would seem almost too hazardous in the advanced cases in which he considers it indicated, he reports that 70 per cent. of the unilateral cases survive the operation and show marked improvement in symptoms.

While sufficient data are not yet available to enable one to form an opinion regarding the usefulness of these procedures, the principle that collapse of a tuberculous lung favors resolution seems to have been established.

Pulmonary Emphysema.

Freund, of Berlin, has recently called attention to the fact that in certain cases of alveolar emphysema the symptoms are due to an abnormal rigidity of the chest-wall. This rigidity he believes to be caused by calcification and other pathologic changes in the costal cartilages resulting in a diminution in their normal elasticity. These changes have been noted more particularly in the second and third cartilages on the right side, but they may be present in any or all of these structures.

Acting upon the suggestion furnished by these observations, Hildebrand, Haasler, and other German surgeons have resected two or more costal cartilages on one or both sides. This allowed a greater excursion of the corresponding ribs during the respiratory movements and gave considerable relief to the dyspnœa.

Goodman has recently reported four cases treated at the Montefiore Home by this method with encouraging results. While the operation cannot be expected to cure the lung lesion, it is reasonable to suppose that considerable relief may be expected in suitable cases.

Gummatous Infiltration of the Lung.

Gummatous infiltration of the lung occurs as a late lesion of syphilis. The symptoms are by no means characteristic. The gummata may break down and form cavities similar to those due to tuberculosis, the difference being that the former are often greatly improved by antisyphilitic treatment.

New Growths of the Pleura and Lung.

Tumors arising from the pleura are rare. The one most frequently observed is *endothelioma*, which grows slowly, and often without symptoms until it gives rise to dyspnœa by encroaching on the lung space. Occasionally it causes a pleural exudate. *Sarcoma*, which is rare, grows rapidly, and is generally associated with a bloody serous exudate.

The physical signs of these growths are those of fluid in the chest; flatness, absence of respiratory sounds, and fremitus. In sarcoma, Warthin states that atypic cells with mitotic figures can sometimes be demonstrated in the fluid.

Primary carcinoma and *sarcoma* may occur in the lung, the former being most frequently encountered.

The symptoms of a primary malignant tumor of the lung are: an afebrile cough, with an area of rapidly advancing consolidation, followed later by dyspnœa, bloody expectoration, a hemorrhagic pleural exudate, and a rapidly advancing cachexia.

The occurrence of these symptoms in an individual who has already a carcinomatous or sarcomatous focus elsewhere in the body is sufficient to justify the diagnosis of a secondary malignant process in the lung. Of the benign tumors of the lung, only echinococcus cysts are of surgical importance.

Echinococcus Cysts.—Echinococcus cysts occur more frequently in the lung than in any other organ of the body except the liver. The disease, however, is rare in the United States, most of the cases occurring in immigrants or those who have visited foreign countries.

Symptoms.—The symptoms of echinococcus disease of the lung are mainly those of pressure, dyspnœa, displacement of the heart, and other mediastinal structures, cough, bulging of the chest, and a dislocation downward of the liver. The signs are those of an intrathoracic tumor.

Prognosis.—The prognosis in this condition is grave if untreated, as rupture may take place into a bronchus and cause asphyxia, or the fluid may become infected and cause a fatal toxæmia.

Treatment.—The treatment should consist in marsupialization or stitching the cyst-wall to the external wound for continuous drainage. Occasionally it may be possible to remove the inner or secreting layer of the sac.

DISEASES OF THE MEDIASTINUM.

Injuries of the mediastinal structures are rare, except in fractures of the spine or crushes of the chest-wall. When the heart and great vessels are injured death results so rapidly that little or nothing can be done. Gunshot wounds may injure the trachea, bronchi, or œsophagus, giving rise to emphysema or septic inflammation.

Acute Mediastinal Cellulitis.

Acute mediastinal cellulitis may arise as a result of trauma, osteomyelitis of the spine or sternum, infection by the lymphatics, or by an extension downward of a cellulitis of the neck. It is most frequently located in the upper and anterior portion of the space, 30 out of 36 cases reported by Hare being located in that region.

Symptoms.—The symptoms are deep-seated pain and tenderness over the sternum, fever, leucocytosis, and evidences of grave toxæmia. Later, the pus may point at the root of the neck, by the side of the ensiform or between the costal cartilages.

Treatment.—The treatment at first should be by local applications of cold and measures to increase the normal resistance. If signs of suppuration appear, the sternum should be trephined and an effort made to locate and evacuate the pus.

New Growths of the Mediastinum.

Both benign and malignant tumors may occur in the mediastinum. The latter are more frequent, the proportion being four to one. Of the benign growths may be mentioned lipomata, fibromata, dermoid, and echinococcus cysts. Of the malignant, sarcoma and carcinoma.

With the exception of the cysts, benign tumors rarely give rise to symptoms requiring surgical interference. Primary carcinoma may develop from the remains of the thymus gland. Primary sarcoma occurs most frequently in the lymph-nodes and is exceedingly malignant.

Secondary malignant growths are not infrequent.

Symptoms.—The symptoms of a mediastinal tumor are pain, cyanosis, and dilatation of the veins of the face and neck, dyspnœa, and in some cases a unilateral or bilateral œdema of the chest-wall from azygos pressure (Fig. 204). The x-rays may reveal shadows which will aid the diagnosis.

Treatment.—The treatment should be at first an exploratory trephine opening through the sternum, which later can be cautiously enlarged with a view to exploring the growth.

Extirpation of accessible tumors, enucleation or drainage of cysts, or simply the removal of pressure by a wide resection of the bone would constitute the most rational treatment.

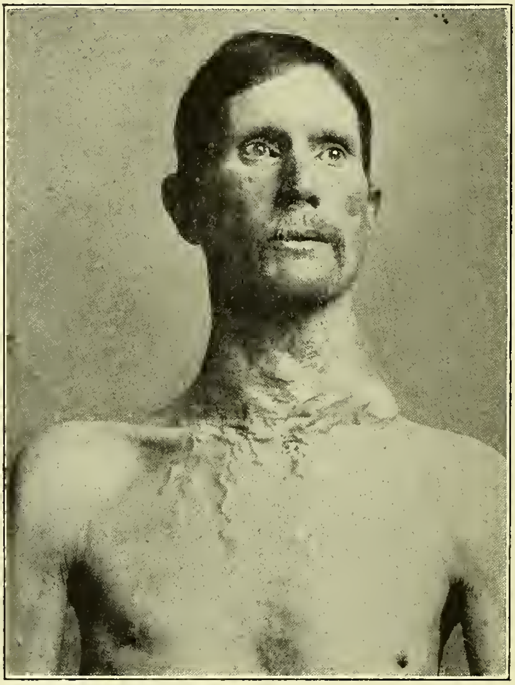
OPERATIONS UPON THE THORAX.

Paracentesis.

This operation is indicated for the removal of an effusion, fluid blood, or air from the pleural cavity. It consists in the introduction of an aspirating needle through the chest-wall at a point where the physical signs indicate the presence of fluid.

When the fluid is not encapsulated, but free in the pleural sac, the site selected is usually in the postaxillary line through the eighth or ninth intercostal space. The region is prepared in the usual manner, and a sterile needle thrust through the chest just above the upper border of a rib to avoid wounding the intercostal vessels. No anæsthetic, as a rule, is required. When the needle is felt to be within the pleural cavity the aspirating tube is attached and the fluid withdrawn. The small wound is afterward sealed with collodion or covered with a strip of sterile adhesive plaster.

Fig. 204.



Dilated veins of head and neck from mediastinal tumor.

The Establishment of an Artificial Pneumothorax.—This procedure is indicated when for any reason it is desirable to produce a contraction of the lung.

A sterile trocar is introduced through the soft tissues down to a rib. The needle is then withdrawn and the canula connected with a reservoir of sterile nitrogen gas by means of a rubber tube. The canula is then pushed upward above the rib and thrust into the pleural cavity. When this is reached the gas will flow into the pleura and gradually compress the lung. From 500 to 2000 ccm. of the gas may be introduced.

A pneumothorax thus created will often last for from three to five months.

Thoracotomy.

Thoracotomy, or creating an opening through the chest-wall with a view to draining the pleural cavity, may be accomplished by an incision between the ribs, or a portion of one or more ribs may be resected. The latter plan is the one generally adopted when the object is to evacuate and permanently drain an empyema. In an encysted empyema the opening should be established over the lowest part of the collection ; in an ordinary empyema the incision should be between the seventh and tenth ribs, depending upon the amount of fluid and the position of the diaphragm. A point should be selected just posterior to the midaxillary line, and an incision made midway between two ribs, dividing the tissues down to the pleura, which may be opened with a knife or by puncture with a director and subsequent dilatation. If a portion of a rib is to be resected, the incision should be made directly over the bone and carried through the periosteum. The soft parts are to be scraped from the bone by a raspatory or periosteum elevator, care being taken to keep close to the bone in order to remove the periosteum completely from its posterior and inferior aspect. This prevents wounding the intercostal vessels. When the bone is cleared, it is cut by bone-forceps or a Gigli saw, and a piece from one to three inches in length removed (Fig. 205). After all hemorrhage is arrested the opening into the pleural sac may be made as above described and the pus evacuated. Two drainage-tubes tied together should then be introduced, or the double-flanged rubber drainage-tube suggested by Wilson. If ordinary tubes are used, they should be introduced only far enough to insure drainage, as long tubes passed into the costodiaphragmatic sinus are a source of irritation, and not infrequently cause deep, slowly healing sinuses. The pleural cavity should not be irrigated except to effect removal of large masses of fibrin. A large absorbent dressing should be applied and the dressings changed only when saturated with the discharge.

In the majority of instances this operation is performed best under general anæsthesia. Local anæsthesia should be employed if the respiration is seriously embarrassed or the condition of the patient does not permit the use of ether or chloroform.

When a more extensive exposure of the thoracic cavity is required, as for decortication of the lung, pneumectomy, or operations on the thoracic portion of the œsophagus, complete removal of one or more ribs with wide retraction of the wound affords ample room for all ordinary procedures.

Thoracoplasty.

Thoracoplasty consists in a resection of several ribs to enable the rigid chest-wall to collapse upon a contracted lung, and thus to obliterate a suppurating dead space. It is indicated in old empyemas which will not heal, and has recently been recommended to allow contraction of the lung for the purpose of obliterating a tuberculous cavity.

Estlander's operation for chronic empyema consists in the removal of portions of several ribs, according to the size and shape of the underlying cavity, but without disturbing the thickened parietal pleura. This may be accomplished by raising a large flap of skin and muscle, thereby exposing four or five ribs from their angles to their attachments to the costal cartilage. The ribs are then resected as described above and the relaxed chest-wall pressed firmly down upon the lung. The original opening into the pleural sac should be enlarged, the cavity curetted, injected with hydrogen peroxide, and irrigated with sterile salt solution.

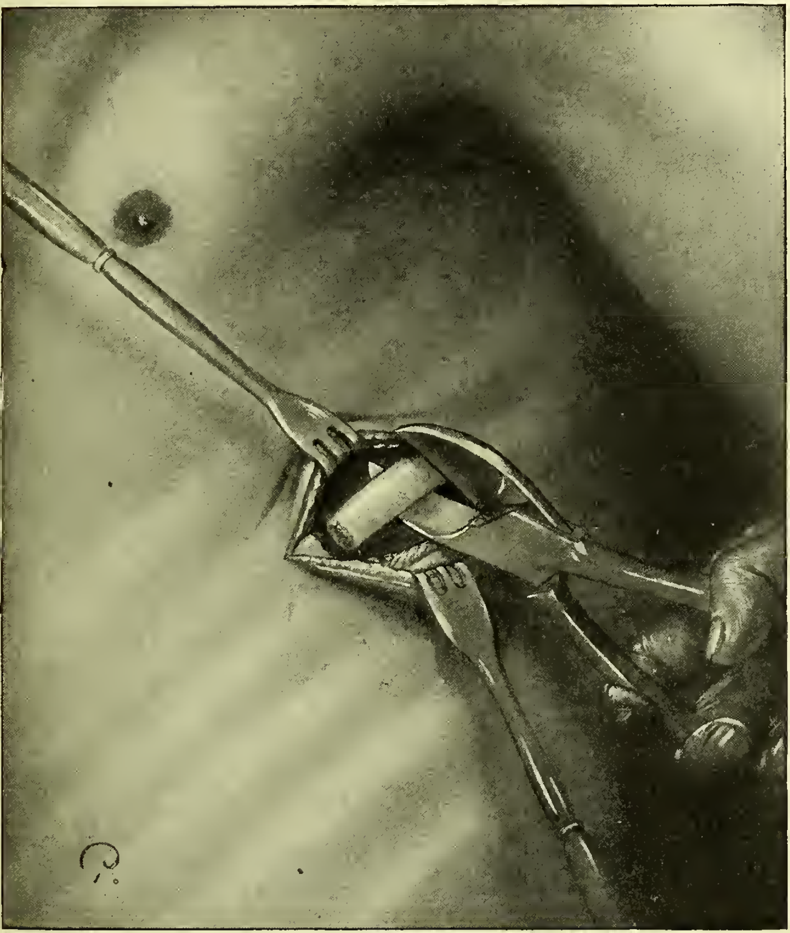
Schede's operation consists in removing not only the ribs, but also the thickened parietal pleura. He advises a large U-shaped incision beginning near the junction of the second rib and costal cartilage, extending downward and backward to the tenth rib, then upward to the axillary border of the scapula. The skin and superficial muscles are separated from the chest-wall and drawn upward, carrying the scapula with them. The ribs, from the second to the lowest limit of the pleural sac, are then removed with heavy bone-forceps and scissors, and with them the intercostal muscles and thickened pleura. The large skin and muscle flap is then replaced, sutured, and pressed firmly against the collapsed lung. The operation is a dangerous one, and should not be attempted unless the surgeon is provided with an adequate number of competent assistants and every facility for meeting and controlling severe hemorrhage and profound shock.

Frederich's operation for the cure of pulmonary tuberculosis is the same as Schede's, except that the resection of the ribs is a subperiosteal resection, the pleural cavity not being opened.

Osteoplastic Resection of the Chest-wall.

This operation is undertaken for exploratory purposes, operations on the heart and pericardium, for the removal of tumors of the lung and pleura, for the removal of foreign bodies in the bronchi and œsophagus, and for the treatment of empyema by the Fowler method.

Fig. 205.



Resection of ribs for empyema. (Brewer, "Keen's Surgery.")

An incision is made parallel with the median line of the body, about one inch from the sternum, exposing the costal cartilages of four or five ribs. From either extremity of this incision two others are made outward over the intercostal spaces. The costal cartilages are divided with bone-forceps, the intercostal vessels double ligated and cut, the incisions carried through the entire chest-wall, and the rectangular flap raised and bent outward, breaking the ribs at the junction of the flap with the healthy chest-wall (Fig. 206). When the necessary intrathoracic procedures have been carried out, the flap is returned and sutured in place with or without drainage. A similar flap may be made in any part of the chest.

Decortication of the lung, or Fowler's operation for empyema, consists in exposing the retracted lung through an osteoplastic opening in the chest, incising the thickened layer of visceral pleura, stripping it from the surface of the lung, and removing it with scissors. In children this often results in immediate expansion of the lung, often to a degree which nearly fills the pleural cavity. In adults it is rarely as satisfactory. It should be advised at an early period before interstitial changes have occurred in the lung to prevent its expansion.

Pneumectomy.—This operation, which consists in removal of a portion of the lung, is occasionally undertaken in extensive wounds or laceration of the organ, for the removal of malignant growths, or, rarely, in tuberculosis or gangrene. The chest is opened by the osteoplastic method or by resection of one or more ribs. The affected portion of the lung is next delivered through the wound, transfixed and securely ligated, after which the diseased area is removed. Nathan Green surrounds the lung above the portion to be removed by a subpleural ligature of silk or heavy chromic catgut, and after the distal portion has been excised, sutures the pleural edges together by a continuous suture of plain catgut.

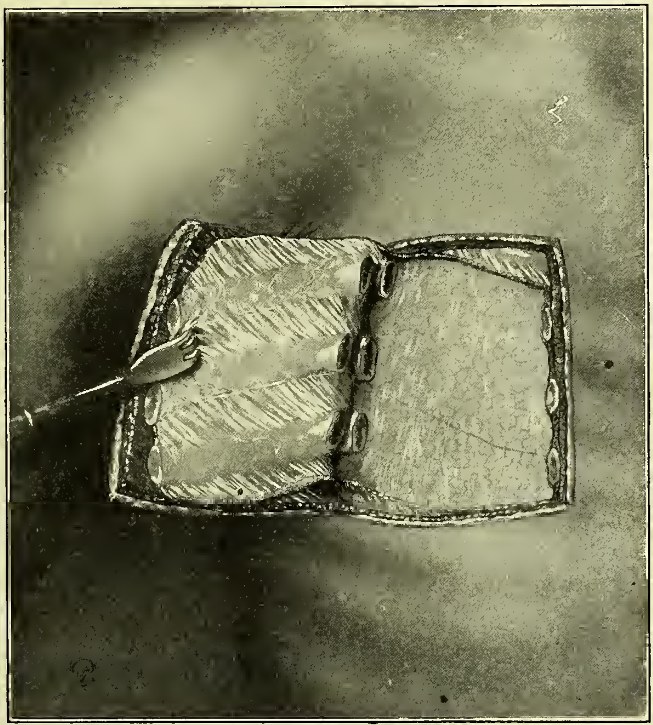
After either procedure the stump is replaced within the pleural cavity and the thoracic wound closed with or without drainage.

Anterior Mediastinal Thoracotomy.—The structures in the anterior mediastinum can be exposed by the operation of Milton, which consists in a median longitudinal section of the sternum, with separation of the two halves. Another method is to make an osteoplastic resection of a rectangular portion of the sternum, dividing the cartilages along one side, sawing transversely through the sternum above and below, and turning the flap to the opposite side, breaking the cartilages beneath the cutaneous pedicle. In these operations the greatest care should be exercised to avoid wounding the pleura or the great vessels issuing from the base of the heart.

Methods of Avoiding the Dangers of Pneumothorax in Operations Upon the Lung and Mediastinal Organs.—While an uncomplicated unilateral pneumothorax is not a source of grave danger to an individual with a sound lung on the opposite side, when such a pneumothorax is associated with a serious operation upon the lung or one of the mediastinal structures, it adds greatly to the operative risk. When both pleural cavities are opened the result is generally fatal.

To avoid the serious consequences of operative pneumothorax, Sauerbruch devised an hermetically sealed operating chamber or cabinet in which the patient could be placed with the head protruding through an air-tight rubber collar. The cabinet was constructed of metal and glass and was large enough to accommodate the operator and two or more assistants. His method of procedure is as follows: The patient is placed upon the operating table, the head drawn through the window, and the rubber collar adjusted. Ether is administered by an outside assistant. When all is ready, the operator and his assistants enter the cabinet, which is then closed, and the atmospheric pressure lowered by means of an electric air-pump. It is found that when the negative pressure

FIG. 206.



Osteoplastic thoracotomy. (Brewer, "Keen's Surgery.")

inside the cabinet is equal to 10 or 12 mm. of mercury, one or both pleural cavities can be freely opened without any untoward effect.

By means of this cabinet Sauerbruch and others have been able to carry out extensive operations upon the lung, œsophagus, and other organs without respiratory or circulatory embarrassment.

Brauer, Robinson, Nathan Green, and other experimenters have devised methods of maintaining lung expansion by means of positive pressure devices which promise equally good results.

The general plan of these is to introduce into the trachea air under increased pressure by means of a snugly fitting intubation-tube or tracheal canula connected with a specially constructed air-pump or bellows.

While this work is still in the experimental stage, the results so far obtained show that much may be accomplished by these methods to reduce the grave risk of intrathoracic operations.

Quite recently Elsberg has shown, both by animal experiments and by observations on clinical patients, that the disturbances due to pneumothorax are to a large extent mitigated by simply placing the patient in a ventral position on the operating table.

CHAPTER XVII.

DISEASES OF THE MAMMARY GLAND.

Acute Mastitis.

THIS is a septic inflammation of the glandular and areolar tissue of the breast. It may occur in either sex, but is far more common in women. Although acute mastitis may arise from wounds and other traumata, and from infection conveyed from other parts by means of the bloodvessels or lymphatics, in the great majority of instances the disease arises in nursing women, and is due to infection of the milk-ducts from an inflamed and fissured nipple.

The **symptoms** of acute mastitis are pain, tenderness, and an increased sense of weight and heat in the breast, with superficial redness and œdema of the skin. On palpation one or more hard, tender lumps may be felt in the breast; or the entire gland may, rarely, be the seat of a massive induration. There is often a chill at the beginning of the infection, with elevation of temperature and pulse-rate and a general feeling of malaise. The occurrence of indurated areas in the breast of a nursing woman without fever or other evidences of constitutional disturbance is frequently observed, and is due to an oversecretion of milk which is not regularly removed by the nursing infant. In these cases massage, hot applications, and the use of the breast-pump will cause the indurations to disappear, and the secretion soon accommodates itself to the needs of the child. If, however, this "caking of the breast" is neglected, it often gives rise to genuine mastitis.

Acute septic mastitis may in some instances under early appropriate treatment subside, the individual areas gradually disappear, and the breast-tissue return to its normal condition. In most cases, however, the disease progresses, and suppuration occurs in one or more regions in the gland. If the suppuration is superficial, it is indicated by a deep-red or purple discoloration of the skin, which is raised and presents an area of softening and fluctuation. If the suppuration occurs deep in the tissue of the breast, these signs may be wanting. The presence of pus is indicated by continued pain, fever, chills, sweats, a leucocytosis, and a failure of the induration to subside after a reasonable time. If the suppuration takes place beneath the breast—*submammary* *abscess*—the entire gland is raised as if on a water-bed and is abnormally movable on the chest-wall, fluctuation can often be detected around the periphery of the gland, and occasionally by placing a hand on either side of the breast a wave of fluid may be appreciated beneath the gland.

Treatment.—In the early stages, hot fomentations applied every three or four minutes for half an hour, three or four times in the course of the day, with rest in bed, saline cathartics, and removal of the breast milk, will occasionally cause the symptoms to disappear. If the disease progresses and suppuration occurs, nursing should be stopped and the pus evacuated early by free incisions radiating from the nipple to avoid cutting the large milk-ducts. Several incisions are often necessary, and when the abscesses are deep the intervening tissue should be broken down by the finger, the cavity freely irrigated, treated with hydrogen peroxide, packed with sterile gauze, or drained with rubber tubes. The use of Bier's section cups in acute abscess of the breast is often of the greatest service, as it enables the surgeon to make smaller incisions, frequently does away with the necessity of drainage-tubes or packing, and shortens the duration of treatment. If the suppuration is beneath the breast, the incisions should be made around the periphery. It occasionally occurs that a breast may be so completely destroyed by suppuration and the resistance of the individual so reduced by the prolonged toxæmia that complete removal of the gland is necessary.

Chronic Mastitis.

Chronic mastitis occurs in two forms, one following an acute attack of the disease, and one arising independently of infection.

In the first variety, after an acute or subacute mastitis with or without suppuration, more or less extensive areas of induration may persist for years after disappearance of the acute symptoms, sometimes causing neuralgia and pain from the pressure of clothing. Occasionally the pain and discomfort in these cases are extreme, and often they are aggravated at the menstrual epoch.

In the second variety, *chronic interstitial mastitis*, the entire breast may be affected by an overgrowth of the interstitial fibrous tissue, which may, by its contraction, occlude the milk-ducts, giving rise to cysts, single or multiple, and eventually to a general atrophy of the glandular substance. In these cases the breast feels lumpy on palpation, and numerous indurated areas are present, usually oblong and fusiform in shape, running from the periphery toward the nipple. In the localized form a single hard nodule may be felt, or several nodules may be present in one part of the gland, the remaining portion being apparently normal.

This condition may occur in young unmarried women during the childbearing period, but chiefly at the menopause. It is rarely accompanied by pain or other symptoms, and is generally discovered by accident. In neurotic subjects the discovery of such a condition often leads to grave apprehension and other neurasthenic symptoms, including pain and a sense of fulness and paræsthesias.

The **diagnosis** of this disease is often of the greatest importance, on account of its close resemblance to the earliest stages of carcinoma. The chief features of the condition are the presence of one or more dense masses of induration in the breast-tissue, which are not sharply circumscribed, but which fade out gradually into the surrounding healthy gland-tissue. They are movable, are not attached to the skin or pectoral muscle, their growth is exceedingly slow, and they are not associated with enlargement of the axillary lymph-nodes.

If unmolested, chronic mastitis may lead to atrophy of the gland or a condition of general cystic degeneration. There is also evidence to warrant the belief that chronic mastitis favors the subsequent development of malignant disease in a breast.

Treatment.—In all cases in which doubt exists regarding the nature of a hard nodule in the breast it should be removed and subjected to microscopic examination. In women at or near the menopause chronic mastitis should be treated surgically, either by removal of an isolated nodule or by removal of the entire gland when it is the seat of the diffuse form of the disease.

Galactocele.

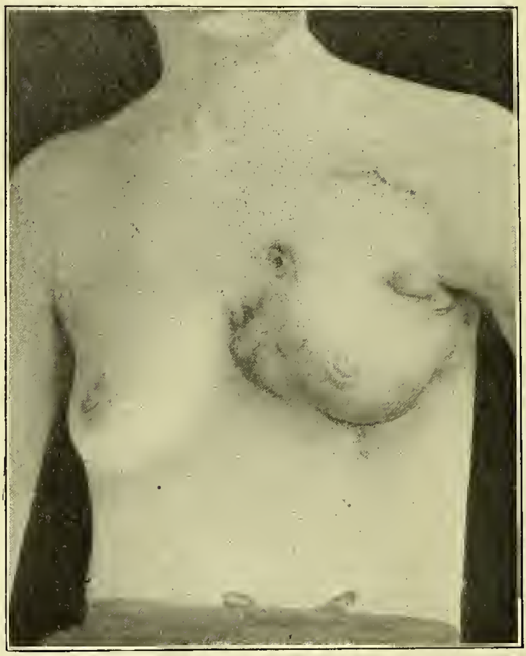
As a result of an inflammatory process or from some other cause, one or more of the breast ducts may become distended with milk, forming an oval, elastic tumor. After a certain length of time the fluid constituents of the milk may become partly absorbed, leaving a thick, creamy, semisolid mass, resembling tuberculous pus. To this the term galactocele has been applied. The condition is an exceedingly rare one and occasionally is mistaken for new growth. As a rule, the disease gives rise to no painful symptoms, and its presence is discovered by accident.

Treatment.—The treatment should consist in evacuation of the cyst by incision or trocar, and the application of pure carbolic acid to its walls; or by complete removal.

Syphilitic Lesions of the Breast.

An initial lesion may occur on the nipple of a woman nursing a syphilitic child not her own. As in other situations, the disease appears as an indolent indurated ulcer with marked axillary gland enlargement. Mucous patches, mucous tubercles, and condylomata may also occur in the secondary stage of the disease, about the nipple or the areola, and upon the raw surfaces of pendulous breasts. Gummata are comparatively rare. When they occur in the gland-tissue they must be distinguished from new growths. This generally is easy by recognizing the peculiar elastic consistence of the tumor, by the history and presence of other evidences of the disease, and by its rapid disappearance under appropriate treatment.

FIG. 207.



Tuberculosis of the breast.

Tuberculosis of the Breast.

Tuberculosis of the breast may occur as a cutaneous lesion—*lupus*—which has already been described, or as a localized or diffuse tuberculous inflammation of the gland. In the localized

form there may be a single slowly growing hard tumor with enlargement of the axillary lymph-nodes. The tumor is not sharply circumscribed and the disease may be mistaken for carcinoma. The tumor is m [redacted]
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Paget's

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rare. It is characterized

skin, which is red and tender. It begins on the nipple or the areola, and may extend for a variable distance in the skin covering the gland. It resembles eczema in appearance. There is a small amount of secretion, which dries and forms scabs or crusts. There is often a burning or itching sensation. It differs from simple eczema in that its borders are more sharply defined and often slightly raised, and that it is not relieved by the ordinary methods of treating eczema.

The **treatment** of this condition when the diagnosis is established should be complete removal of the gland.

Diffuse Virginal Hypertrophy of the Breast.

A rare condition occurring at or near puberty, characterized by a bilateral hypertrophy of the breast tissue. The abnormal growth is gradual and, as a rule, is unaccompanied by pain or discomfort other than an increased sense of weight. The breasts may grow to an enormous size and give rise to great deformity (Fig. 208).

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wo types are recognized,
in which the cysts are
thin walled and contain turbid or brownish fluid, the other in which many of the alveolar spaces and cysts are filled with an overgrowth of epithelium, forming adenomatous masses. Both varieties are prone to undergo carcinomatous degeneration, but this tendency is much more marked in the adenomatous type.

The purely cystic type has much in common with the condition described as chronic interstitial mastitis.

Symptoms.—The symptoms of this disease are those of a slowly developing, irregular mass in the substance of the breast without pain, retraction of the nipple, adhesion to the muscle or skin, and without involvement of the axillary nodes. To the examining hand the mass often resembles carcinoma, in that it is diffuse and fades away gradually into the surrounding tissues. Occasionally fluctuation can be detected if a large cyst is present near the surface. Not infrequently two or more masses may be detected in the same breast, and bilateral involvement is not uncommon. The tendency of this disease to undergo malignant change renders treatment by removal of the entire gland imperative.

TUMORS OF THE BREAST.

The female breast is frequently the seat of tumor. It has been estimated that one-fifth of all tumors, both innocent and malignant, occur in the breast. While innocent tumors occur with a fair degree of frequency in the breast, the number of malignant growths in this gland is so great that the proportion of the latter is three to one of the former. As a general rule, it may be stated that the innocent tumors develop early in life, the malignant at a later period; to this, however, there are many exceptions, as cancer has frequently been observed between the ages of twenty and thirty, and sarcoma and adenoma may occur at any age.

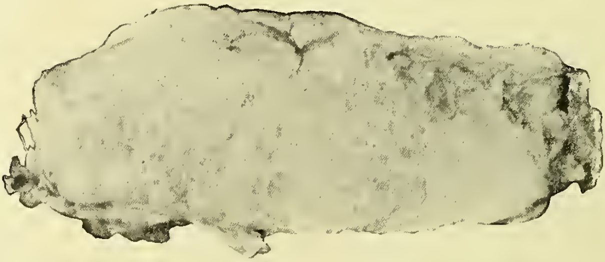
Tumors of the breast may be divided into three chief groups, the *adenomata*, the *carcinomata*, and the *sarcomata*. Other varieties are exceedingly rare. Lipomata, angiomata, myxomata, lymphatic and hydatid cysts have been reported.

Adenoma. Fibro-adenoma.

Adenoma is a tumor composed of a mass of glandular tissue surrounded by a fibrous capsule. Adenomata may occur as single or multiple tumors in one or both breasts. They are rounded in shape, hard and elastic to the touch, are freely movable, do not become adherent to the skin or muscle, are not accompanied by enlargement of the axillary lymph-nodes, and show no tendency to recur after complete removal. These tumors vary in size from that of a hazelnut to that of an orange, or even larger. They occur in the majority of instances during the menstrual life of the individual. They are rare after fifty, and have not been reported before the thirteenth year of life. In the majority of adenomata there is an overgrowth of connective tissue, and to these tumors the term *fibro-adenoma* has been applied (Figs. 209 and 210). When the epithelial elements are active, fluid may be secreted in one or more of the glandular acini and cysts are formed. To describe this variety the term *cysto-adenoma* or *adenocele* has been employed. In other instances. the tumor is made up almost entirely of dense fibrous tissue compressing the ducts and glandular elements. To this variety the term *intercanalicular fibroma* is applied. Occasionally one portion of a tumor may be distinctly fibrous and another glandular and cystic. These tumors are often spoken of as *fibrocysto-adenomata*. Small tumors occasionally develop in the walls of the ducts, project into the lumen, and give rise to a collection of fluid, causing a fusiform dilatation. They often have a papillomatous appearance, and are spoken of as *intracanalicular adenopapillomata*.

Adenomata, as a rule, produce no symptoms; they are generally discovered by accident and their growth is exceedingly slow. There is positive evidence to show that in certain rare cases these tumors, after remaining for a long period of time as stationary or slowly developing innocent growths, may suddenly change their character, grow rapidly, and become converted into malignant neoplasms. Three such examples came under the author's observation in one year.

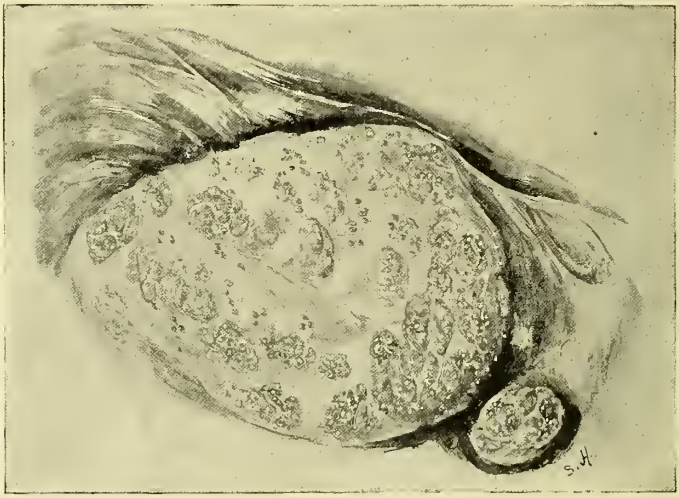
Fig. 209.



Fibro-adenoma of male breast.

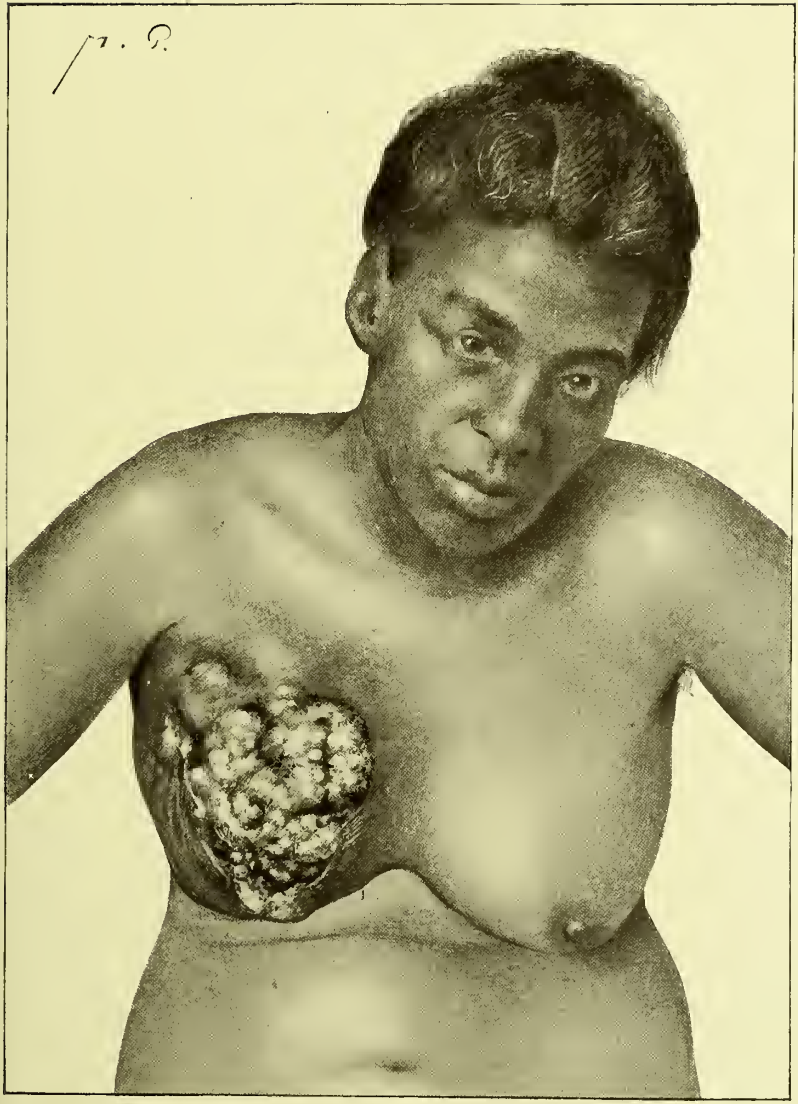
Diagnosis.—Adenomatous tumors are to be distinguished from carcinomata by the fact that they are of slow growth, are distinctly circumscribed, are freely movable, and not adherent to the skin or muscle, are not accompanied by retraction of the nipple or axillary involvement; from the sarcomata, by their slow growth and com-

Fig. 210.



Fibro-adenoma of female breast.

PLATE VIII



Ulcerating Sarcoma of Breast.

paratively small size, and by the fact that they are frequently multiple; from chronic interstitial mastitis, by their round shape, their distinctly circumscribed borders, and by evidences of encapsulation.

Treatment.—On account of the possibility of these tumors becoming converted into malignant growths, their removal should be advised in all cases. As a rule, this is accomplished best by an incision radiating from the nipple or around the periphery of the gland. The tumor when exposed is easily enucleated. In certain cases when multiple tumors exist or when there is extensive cystic disease removal of the entire gland is advisable.

Sarcoma.

Sarcoma is a comparatively rare disease of the breast. It occurs in two forms, the round-cell, rapidly growing variety, which later infiltrates the breast-tissue; and the spindle- or mixed-cell tumor, which grows more slowly and is generally encapsulated. The former is exceedingly malignant, occasionally involves the axillary lymph-nodes, and is disseminated by the blood-current; the latter is less malignant, is often cured by early and complete removal, and was formerly described under the term "recurrent fibroid tumor of the breast."

Sarcoma generally arises from the connective tissue of the gland, and in its growth often includes portions of the glandular substance, which may later develop into cysts, forming the type known as *cystosarcoma.* Secondary myxomatous changes may rarely occur in a sarcoma. When this occurs the tumor is spoken of as a *myxosarcoma.* Cartilage is occasionally found in these growths, as in those of the parotid gland, giving rise to the term *chondrosarcoma.*

Breast sarcoma occurs, as a rule, in individuals under thirty years of age. Its growth is, in the early stages, painless, but in the case of the round-cell variety exceedingly rapid. Nursing seems to exert a stimulating influence upon the growth of breast sarcomata, as they progress with great rapidity during lactation.

The **diagnosis** of sarcoma of the breast is by no means always an easy matter, and in certain cases impossible before a microscopic examination is made of the tissue. The chief clinical points are its rapid growth, the age of the patient, and the late involvement of the lymph-nodes. The encapsulated fibrosarcomata resemble the fibro-adenomata in being sharply circumscribed tumors, and occasionally cystic; they differ, however, in that they grow much faster, attain a large size, and are always single. The round-cell infiltrating sarcomata may closely resemble the rapid and cellular carcinomata (Plate VIII). Absence of enlargement of the lymph-nodes would favor the diagnosis of sarcoma; if these are involved, the diagnosis must rest in doubt until the tissue can be examined microscopically.

Treatment.—Early and complete removal is the only rational treatment of this disease. In the slowly growing fibrosarcomata the entire breast and axillary glands should be removed; in the more rapidly growing diffuse sarcomata the complete Halsted operation should be performed. These measures, if carried out at an early period of the disease, often will bring about a radical cure; and it should be remembered, moreover, that a local return of the growth often may be successfully treated by surgical means even after three or four recurrences. In the rapidly growing round-cell variety the prognosis is always grave, as dissemination of the disease by the blood-current occurs at an early period, and operations which are at all delayed are apt to give but temporary relief.

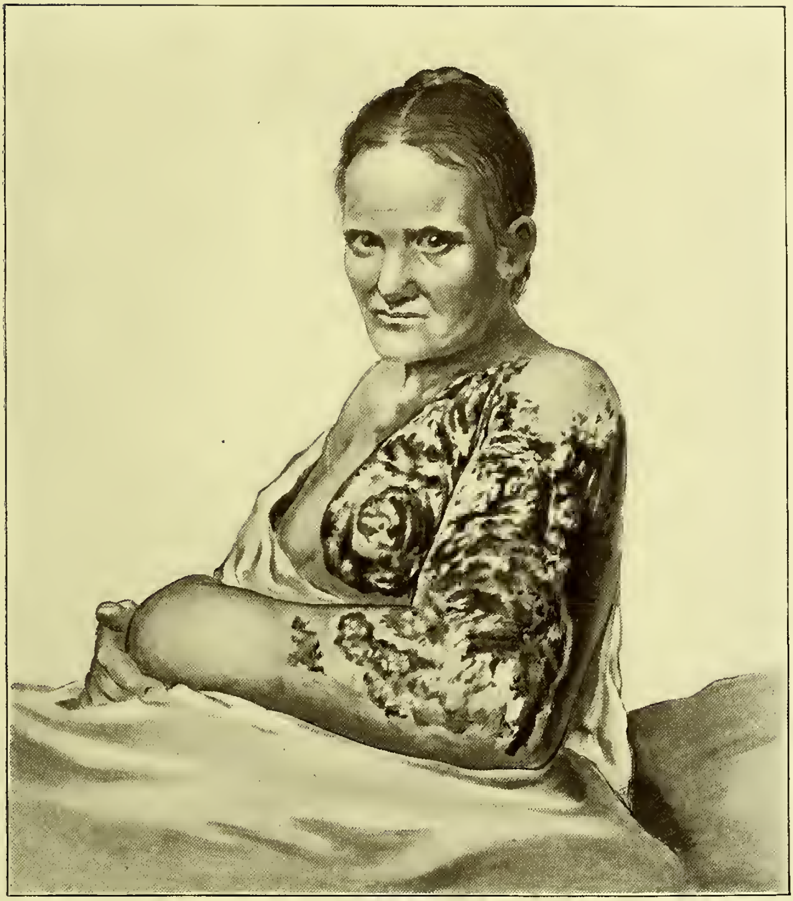
In inoperable sarcomata of the breast and in extensive recurrences the x-rays offer a chance of improvement, arrest of the growth, or radical cure. The use of erysipelas toxin in these cases has been followed by success in a few instances.

Carcinoma.

Carcinoma is by far the commonest disease of the female breast. It is far more frequently encountered than sarcoma, the proportion being about 12 to 1. If we exclude the uterus, certainly no organ in the female body is as frequently the seat of cancerous disease as the breast. The disease may rarely occur in the male breast. Regarding the age at which it develops, it may be stated in general that it is a disease of late middle life, the greatest number of cases occurring in individuals between forty and fifty years of age. It, however, may occur at any earlier period, and several instances are on record of the disease in women between fifteen and thirty. The influence of the married state, pregnancy, and lactation is apparently unimportant in the etiology of cancer, but carcinoma occurring in a breast during pregnancy invariably assumes an extremely malignant type. Heredity plays a certain part in the etiology, and there is some evidence to suggest that contagion may be an important factor. The history of a blow or other trauma is misleading, as few women reach the cancer age without suffering such injuries. Irritation of the gland, produced by the presence of other new growths or of a chronic mastitis, is thought by many observers to favor development of this disease.

Carcinoma of the breast may arise from the glandular elements or from the milk-ducts. The former is called *acinous* cancer; the latter, *duct* cancer. Acinous cancer, which is by far the commoner

PLATE IX



Neglected Carcinoma of Breast.

variety, occurs in two forms: the hard fibrous carcinoma or *scirrhus,* and the soft cellular variety or *encephaloid* cancer.

Scirrhous cancer of the breast is the commonest form of the disease. It may begin in any part of the gland, but is more frequently seated near the nipple or in the upper and outer quadrant.[1] When first noticed, it is usually an oval, deep-seated, indurated movable lump of stony hardness. It is not sharply circumscribed, and as it develops it can be felt to grow outward into the surrounding tissues, which gradually become more infiltrated and dense. Adhesions soon form between the tumor and the skin, and also with the underlying muscle. The nipple is frequently retracted, and the axillary lymph-nodes become enlarged. The latter occurs early in the disease, probably about the second month, but owing to the location of the glands and the surrounding fatty tissue they are rarely recognized until a later period. As the growth of the tumor advances and the surrounding tissues are infiltrated, an atrophy or shrinkage of the entire gland may occur in certain cases, from contraction of the fibrous tissue, giving rise to the variety sometimes called "withering cancer." In the majority of instances, however, the growth involves a large part of the gland, the overlying skin, and the underlying muscles and chest-wall. If allowed to progress, the subcutaneous lymph-spaces may become infiltrated with the disease, which results in a hardening of the skin with the formation of numerous dense white nodules. When this extends over a large area of the chest-wall, respiration may be embarrassed, and the condition is spoken of as *cancer en cuirasse.* As the growth progresses the lymphatics of the axilla and supraclavicular region enlarge, forming later massive tumors which press upon the vessels and nerves and cause œdema of the arm and neuralgia in the branches of the brachial plexus. In most cancerous growths of the breast the first lymph-nodes to become involved are those lying along the inferior border of the great pectoral muscle. Exceptionally, when the disease first attacks the upper and inner quadrant, the mediastinal nodes are primarily affected, chiefly through lymph-channels entering the thorax through the second intercostal space. Lymphatic œdema may occur from obstruction of the lymph-channels, producing a condition of the skin of the upper extremity and shoulder resembling elephantiasis, as seen in Plate IX., which represents the latest stages of a neglected breast cancer.

Encephaloid cancer presents a very different clinical picture.

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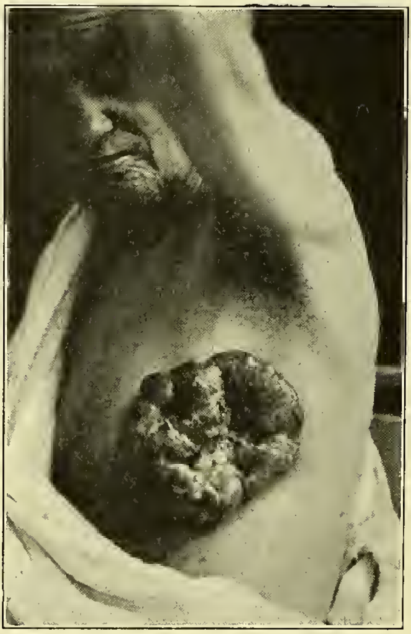
[1] It must be remembered that the upper angle of the breast, which normally extends toward the axilla along the lower border of the pectoral muscle, is occasionally surmounted by an oval mass of glandular tissue, or such a mass may exist without direct glandular connection with the breast, resembling a supernumerary mamma, in which carcinoma may develop.

The growth occurs as a soft, elastic, rapidly growing tumor, which soon infiltrates the entire tissue of the breast and does not produce retraction of the nipple. The disease early infects the lymphatics and infiltrates the skin, which becomes discolored and breaks down, leaving a foul, rapidly fungating ulcer (Fig. 211). Rapid dissemination of the disease takes place, which speedily leads to a fatal termination.

Duct cancer is the rarest and least malignant form of the disease. It occurs as a small, slowly developing papillomatous tumor growing from the walls of a dilated milk-duct, usually near the nipple. It occurs generally about the menopause, when the glandular structure of the breast atrophies and the galactophorous ducts are prone to enlarge, forming a general cystic condition of the breast. The tumor is softer than the scirrhous variety, is often covered by a bluish or purplish skin, and on section is found to be surrounded by a capsule made up of the walls of the dilated duct.

Fig. 211.



Ulcerating carcinoma of breast.

Symptoms.—The early growth of a carcinoma of the breast is, as a rule, unaccompanied by symptoms of any kind. Pain is rarely present until the disease has extended to the axillary lymph-nodes and produces pressure on the nerves. In the earlier stages of scirrhus and encephaloid a sense of weight in the breast may be experienced by the patient; and in neurotic subjects, shooting pains, burning sensations, and other forms of paræsthesia may be present. Genuine pain, shooting into the breast and down the arm, is a fairly constant late symptom, which may be so severe as to cause great suffering and to necessitate the use of opiates. The presence of an intermittent bloody discharge from the nipple is one of the earliest signs of duct cancer. Loss of weight and strength, anorexia, anæmia, and a peculiar sallow, unhealthy appearance of the skin develop late in the disease, and are due to absorption of toxins or to secondary involvement of other organs. As this cachexia develops the patients become bedridden and exhausted, and eventually die of asthenia.

Prognosis.—In general it may be stated that the disease if untreated always leads to a fatal termination. The more cellular the growth the more rapid its course. In cases of "withering cancer" or the exceedingly slow-growing duct cancers the progress may be so delayed that death not infrequently takes place from other causes. The average duration of life in an untreated case of encephaloid carcinoma of the breast is from nine to eighteen months; in ordinary scirrhus, from two to three years. The prognosis in cancer of the breast treated by modern operative measures has steadily improved during the past twenty years. In general, it may be stated that the operative mortality should not be over 3 per cent., and the three-year cures should be upward of 30 per cent. In selected early cases, where the growth is small and no enlarged lymph-nodes can be felt in the axilla, the percentage of cures is between 60 and 70.

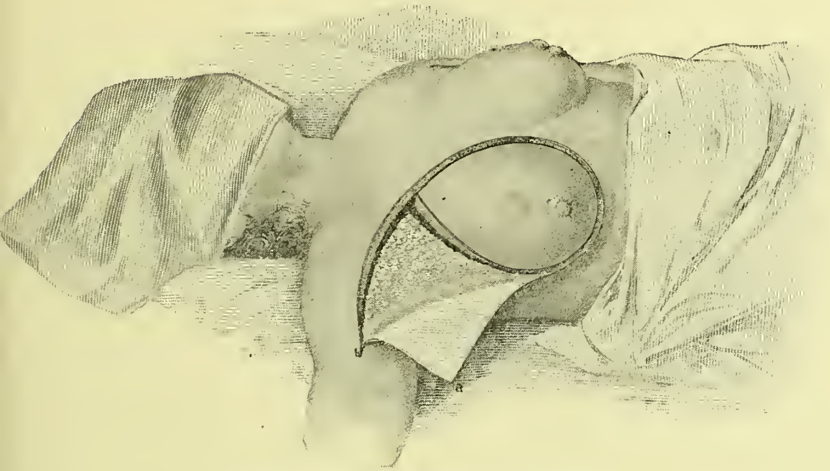
Diagnosis.—While accurate diagnosis is a comparative simple matter late in the disease, when all the characteristic symptoms and signs are present, in the earlier stages, when treatment offers a chance for radical cure, the diagnosis is often attended with considerable difficulty. The presence of a hard tumor in the breast of a woman over thirty should always be regarded with suspicion. If the growth progresses rapidly, is single, and is early associated with retraction of the nipple, enlargement of the axillary lymph-nodes, or dimpling of the skin over the centre of the mass, the probabilities are that it is carcinomatous in character. If in addition to this, the growth infiltrates the gland without distinctly circumscribed limits and the overlying integument assumes the appearance of "pig skin," or dense lymphatic infiltration, the diagnosis is certain. In differentiating between an early cancerous nodule and chronic interstitial mastitis, the fact that the nodule is single and its growth progressive would favor the diagnosis of cancer; the absence of any sharp line of demarcation between it and the surrounding breast-tissue would serve to distinguish it from an adenomatous tumor. This fact would also enable one to exclude encapsulated spindle-cell sarcoma, while the comparatively slow growth and limited extent of a beginning scirrhous carcinoma would distinguish it from the rapidly growing, infiltrating, round-cell sarcoma. There are, however, no distinguishing features which will enable one to differentiate between an encephaloid carcinoma and a round-cell sarcoma, unless it be that the growth of the latter is more rapid and unaccompanied by enlarged lymph-nodes.

In all doubtful cases early and complete removal of the suspicious nodule is to be recommended. This should always be effected without cutting into the diseased mass. Under favorable conditions the tumor may be immediately examined by means of frozen sections, and if its malignancy is demonstrated the complete operation can be performed at once; or if this is not possible, the examination should be made at a later period and the subsequent treatment determined by its result.

Treatment.—As soon as the diagnosis of carcinoma of the breast is established, complete removal of the disease should be undertaken at the earliest possible moment. While some surgeons still advise simple removal of the gland and the axillary contents in cases of early fibrous carcinoma, statistics prove that the general employment in these cases of the complete Halsted operation is followed by a larger percentage of cures than when any other method is adopted. This method is applicable to all cases of carcinoma of the breast when the disease appears limited to the mammary gland and the axillary lymph-nodes. If the growth is small and the lymph-nodes but little if any enlarged, removal of the breast, the pectoral muscles, and the areolar tissue of the axilla will be sufficient. If, however, the axillary nodes are extensively involved, and especially if the lymphatics high up in the axilla under the tendon of the pectoralis minor muscle are diseased, the supraclavicular space must be exposed and cleared of its lymphatics and areolar tissue. If the disease has involved the chest-wall, the great vessels of the axilla, and large areas of the skin (*cancer en cuirasse*), or if the supraclavicular lymph-nodes can be felt, the operation should not be undertaken with a view to radical cure of the disease, although in certain cases this or less extensive operations are justifiable as palliative measures. In a recent publication Barker states that "the more localized the primary focus of carcinoma in the breast is, the more wide-reaching should be the excision; that is to say, there is in such cases a fair prospect of complete eradication of the disease by a wide-reaching operation. The converse rule appears also to have much to recommend it, viz., that the more wide-reaching the disease, the more clearly should the operator keep palliation in view, and by limiting his operation avoid the risk of extreme shock."

The operation for complete removal of the female breast is carried out as follows: The axilla should be shaved and the entire region of the neck, shoulder, upper arm, breast, and side wall of the chest should be prepared in the usual manner. After the patient is anæsthetized the arm of the affected side should be held at a right angle with the body, and an incision made from the humeral insertion of the pectoralis major tendon over the point of the shoulder and then downward on the chest-wall to the inner side of the nipple to a point two or three inches below the lower margin of the gland; from the upper portion of this cut another incision is carried downward along the edge of the pectoral muscle and then curving inward to meet the lower extremity of the first incision; or if the disease is more extensive and it is desirable to remove a larger area of skin, the incision is modified as seen in Fig. 212. This incision is carried through the skin and superficial fascia, which are dissected free on either side to the muscular layer, exposing the pectoral muscle throughout over its entire length. The tendon of the muscle is next separated from its attachment to the humerus and retracted downward (the clavicular fibres may be left), and the attachment of the pectoralis minor muscle exposed and severed (Fig. 213). The axillary space thus exposed is cleaned from above downward of all fascia, lymphatics,

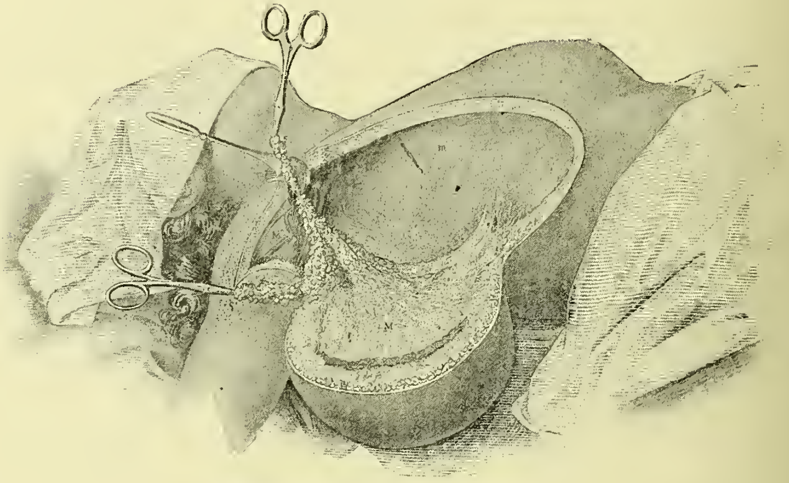
Fig. 212.



Halsted's breast operation, skin-incision.

and areolar tissue, care being taken when the lower limit is reached to preserve if possible the subscapular and posterior thoracic nerves. When the axillary space is thoroughly cleared, the costal and sternal attachments of the pectoralis major muscle are divided, as well as those of the pectoralis minor, and the entire mass, consisting of the breast, both muscles, and the axillary glands and areolar tissue, is removed. If the supraclavicular space is to be explored, a curved or straight incision is made above the clavicle, and the lymphatic structure and areolar tissue removed along the subclavian vessels and for a distance of two or more inches above the clavicle behind the sternomastoid muscle. When this is accomplished, the wounds are closed as completely as possible with silk-worm gut sutures, and the remaining uncovered portion immediately covered with Thiersch skin-grafts taken from the thigh or arm. A small opening for drainage should be cut through the axillary flap and a small cigarette drain introduced, after which a large gauze and cotton dressing should be applied and the arm fixed at a right angle across the chest, and the whole held by a large many-tailed bandage.

FIG. 213.



Halsted's breast operation, later stage.

As a rule, there is little reaction after the operation if care is taken to avoid hemorrhage and infection. Often the patients are allowed to sit up on the fifth or sixth day. If the temperature remains normal, the dressing need not be removed for ten days.

CHAPTER XVIII.

INJURIES OF THE ABDOMEN.

Contusions.

CONTUSIONS of the abdominal wall are of frequent occurrence, resulting from all manner of traumata. They vary in their results from a slight feeling of soreness and general discomfort to rapidly fatal collapse. This difference, which is observed not infrequently in injuries quite similar in their method of production, in the amount of force expended, and in their outward signs, is due to the presence or absence of associated internal or visceral injury.

The effects of a blow on the anterior abdominal wall are modified by the condition of the abdominal muscles. An unexpected blow on the pit of the stomach received while the muscles are in a state of comparative relaxation is often followed by severe shock, nausea, and temporary muscular weakness, due, as Crile has shown, to the concussion being transmitted to the pericardial portion of the diaphragm. If, however, the blow is expected and the abdominal muscles are rigidly set, little or no inconvenience is produced. The same is true of other parts of the abdomen; an expected blow or contusion produces, as a rule, less visceral injury than one received while the abdominal wall is relaxed. A blow directly over a distended hollow viscus, as the stomach, intestine, or urinary bladder, may cause a rupture and extravasation of the contained matter, while a like blow received when the organ is in a state of collapse may produce no untoward effect. Enlargement of the liver and spleen to such an extent that they lie below the protecting arches of the ribs, favors their injury as a result of abdominal trauma. It must be remembered that extensive and fatal visceral ruptures may be produced by comparatively slight contusions; that the amount of internal injury is due more to the condition of the organ and the protecting abdominal muscles than to the force of the blow.

The *extraperitoneal* results of abdominal contusions are: bruises of the skin; subcutaneous ecchymoses; hæmatomata beneath the skin, between the muscular layers, or between the muscles and the peritoneum; rupture of the muscles at their points of attachment or in the intervening portions; contusion or rupture of the kidney. The *intraperitoneal* injuries may be: contusion and rupture of the parietal peritoneum; contusion or rupture of the stomach or intestine; contusion or rupture of the liver, spleen, or pancreas; and injury to the omentum or mesentery. Ruptures of the bladder may or may not involve the peritoneal cavity. In rupture of any portion of the alimentary canal extravasation of the contained matter will result, producing immediate peritoneal irritation, as evidenced by pain, tenderness, thoracic respiration, retracted abdomen and muscular rigidity, and later will be followed by septic peritonitis. Injuries of the liver or spleen following abdominal contusions are generally found to be more or less extensive fractures, which result in extravasation of blood which varies in amount with the extent of the injury. Such hemorrhages are indicated by a condition of shock and by more or less localized peritoneal irritation. Injuries of the omentum and mesentery are rarely found unassociated with visceral injury. If their vessels are wounded, extensive hemorrhage will result. A distended bladder may be ruptured by a blow over the hypogastrium, but the injury is associated more often with fracture of the pelvis.

Diagnosis.—Contusions of the abdomen are apt to be associated with a condition of early and transitory shock which does not necessarily point to visceral injury. If the results of the injury are limited to the abdominal wall, the symptoms will be those of contusion and laceration of other muscular structures, which are soreness, pain on motion, and tenderness to pressure. If an hæmatoma forms, it will be indicated by the presence of a more or less circumscribed tumor, which, if superficial, will fluctuate, and if situated deeply beneath the thick muscular layers, may simply impart to the examining hand a sensation of elasticity. Occasionally an extensive retroperitoneal hemorrhage in the flank may be felt from in front as a deep-seated abdominal tumor.

If, following an abdominal contusion with or without signs of superficial injury, there is progressively increasing shock, indicated by pallor, nausea, cold extremities, and a weak pulse increasing in rapidity, with localized or general abdominal pain and an appreciable rigidity of the muscles which is not accounted for by local injury, the case is in all probability one of visceral injury. If, in addition to the above symptoms, there is evidence of free fluid in the peritoneal cavity, indicated by dulness or flatness in the flanks, which disappears on turning the patient on the opposite side, or if free gas is present in the peritoneal cavity, evidenced by obliteration of the liver dulness, and if the first depression is followed by gradual rise in temperature, with an increasing pulse-rate, the diagnosis is rendered still more probable. If these symptoms are all progressive and the patient passes rapidly into a state of profound collapse, the diagnosis is certain.

Localized pain with rigidity over the epigastrium points to a rupture of the stomach or injury to the pancreas; pain limited to the right hypochondrium with evidences of free fluid suggests a rupture of the liver; the same on the left side suggests a rupture of the spleen; pain and rigidity about the umbilicus or in the lower part of the abdomen, without other symptoms, suggest rupture of the intestine; pain in the hypogastrium, with the passage of bloody urine or an empty bladder, indicates rupture of that organ; while pain in the flank, with hæmaturia and a retroperitoneal exudate, suggests contusion or rupture of the kidney.

In cases of visceral injury the symptoms and signs are rarely so localized as to warrant a positive diagnosis as to the nature of the lesion, and in many cases the symptoms are so mild, obscure, or misleading that the presence or absence of such lesions may only be surmised. In all cases of doubt the indications are for an immediate laparotomy for purposes of exact diagnosis and treatment, as the symptoms and signs in many cases give no indication of the extent and gravity of the lesion.[1]

The **treatment** of simple contusions of the abdominal wall consists in rest and the application of hot stupes or other soothing measures. If an hæmatoma develops beneath the skin or between the muscles, the rest should be continued until the fluid is absorbed. In large hæmatomata aseptic aspiration of the fluid with subsequent compression will often materially shorten the duration of treatment. If there is evidence of continued extravasation of blood, which is not controlled by pressure, the part should be exposed by incision, the bleeding vessel ligated, or the hemorrhage arrested by gauze packing. Hæmatomata in the flank associated with rupture of the kidney, frequently become infected, giving rise to extensive suppuration, which should be treated by incision and drainage.

In the presence of symptoms indicating visceral injury or severe intra-abdominal hemorrhage, the patient should be immediately prepared for operation. In addition to the usual preparation, the patient, if in severe shock, should be given morphine $\frac{1}{4}$ grain and strychnine $\frac{1}{20}$ grain half an hour before the operation. Fifteen minutes later he should have an enema of hot coffee, which should be held in the rectum until his removal to the operating-table. When the patient is etherized, an intravenous saline infusion should be started before the abdomen is opened. When the symptoms point to no definite locality, a median incision should be made and the peritoneal cavity explored. If gas or free blood escapes when the peritoneum is opened, the abdominal incision should be widely extended and a search instituted for the injured viscus. In the presence of free gas or intestinal contents, the stomach should be drawn into the wound and inspected, after which the colon should be examined from the cæcum to the rectum. If no lesion is found, the small intestine should be lifted out of the abdominal cavity, covered with warm wet towels, and the entire length of the gut inspected from the duodenum to the ileocæcal valve. When the lesion is found, it should be repaired if possible by one or more silk Lembert sutures; or if the wound is too extensive to be closed in this way without causing stricture, the injured area should be excised and the ends united by a Murphy button or one of the methods of end-to-end anastomosis. If on opening the peritoneum hemorrhage only is present, the liver and spleen should first be examined for evidences of rupture. If no injury to these organs is found, the mesentery, greater and lesser omentum, vena cava, pelvic vessels, and abdominal parietes are examined in the order given. This examination is greatly facilitated by removal of the small intestine from the cavity and the use of large gauze sponges in sponge-holders to wipe away the blood from the various parts of the abdomen.

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[1] On two occasions the author has found on exploratory laparotomy complete rupture of the small intestine, the only indications of which were the history of injury, a rapid pulse, and slight tenderness and rigidity of the abdominal wall. On another occasion a transverse rupture of the spleen was found with over a quart of free blood in the peritoneal cavity, in an individual who had walked a mile after the accident and complained only of slight abdominal pain and tenderness. There was, however, in each instance, marked muscular rigidity.

Rupture of the liver is treated by generous gauze packing. As the rent is frequently on the diaphragmatic surface along the falciform or coronary ligaments, the abdominal wall should be forcibly retracted and the right lobe of the liver gently depressed in order to place the gauze around the injured area. In case a median incision is employed, a separate incision should be made along the lower costal border, through which the external portion of the gauze should protrude. If allowed to emerge through the median incision, its removal would tend to draw downward the right lobe of the liver and thus reopen the fissure. An injured spleen can generally be drawn into the wound and its ruptured surface united with sutures. If this is impossible on account of the condition of the patient, the surgeon has the choice of two methods, either to perform a rapid splenectomy, or to press a large mass of gauze into the rent and replace the organ, allowing the outer extremity of the gauze to protrude through a lower lumbar opening. As soon as the abdominal wound is closed the pressure of the other viscera causes the external surface of the spleen with its mass of gauze packing to press against the diaphragm, preventing further hemorrhage. The author has found this latter method quicker than any other, and has always succeeded by it in arresting hemorrhage. It has the additional advantage of saving an important organ. After the source of the hemorrhage is found and secured, the abdominal cavity should be flushed with a large amount of hot saline solution, and the wound closed with through-and-through silk-worm gut sutures. The gauze packing should be allowed to remain in place for from seven to ten days. It should be removed under anæsthesia, and a small wick of gauze inserted in the lower portion of the wound. Success in these cases will depend largely upon the speed of operation, the skill of the anæsthetist in administering only a small amount of ether, and upon the judicious employment of stimulating measures, especially the intravenous saline infusion.

Wounds of the Abdomen.

Wounds of the abdomen are divided into two classes : *non-penetrating wounds*, or those involving only the abdominal parietes without opening the peritoneal cavity ; and *penetrating wounds*, or those which open the peritoneum. The non-penetrating wounds differ in no way from wounds of the soft parts in other regions of the body, with the exception that severed muscles and aponeuroses, if not accurately united, will often lead to a weakening of the abdominal wall and favor the subsequent occurrence of hernia. Every wound, therefore, involving one of these tissues should be carefully disinfected and accurately united by layer suture with a view to obtaining primary union.

Penetrating wounds of the abdomen are, for the most part, caused by stabs or gunshot injuries. Explosions, railway accidents, and attacks by bulls or other infuriated animals, furnish a few examples, but they are so rare as to be justly regarded as surgical curiosities.

Symptoms.—As in the case of abdominal contusions, the symptoms of penetrating abdominal wounds depend upon the presence and character of the associated visceral injury. If the wound is a small one and involves only one of the solid organs, as the liver or spleen, and is unaccompanied by severe hemorrhage, there may be no symptoms other than those of the superficial cut. This is also the case in certain wounds of the alimentary canal, especially those made by the steel bullets of the modern high velocity firearms, as the clean-cut wound is often plugged by a prolapse of the mucous membrane, allowing little or no extravasation of the contents of the gut. The danger in these cases is therefore due mostly to the presence of septic matters introduced from without, which is often so small in amount as to give rise to only a localized peritonitis. In wounds involving the pancreas there is always the added danger that the extravasated pancreatic fluid will produce a fat-necrosis in the neighboring parts, which if infected will lead to extensive suppuration and a high degree of toxæmia. In more extensive wounds accompanied by a large amount of hemorrhage or the extravasation of a considerable amount of infected material from a wound of the stomach or intestine, the symptoms are those of shock: pallor, weakness, a rapid, feeble pulse, restlessness, thirst, subnormal temperature, and cold perspiration, with localized tenderness and muscular rigidity. Later, the temperature rises, vomiting occurs, and if the patient survives the first shock, symptoms of progressive general peritonitis will develop. In larger abdominal wounds protrusion of the intestine, omentum, and sometimes of other intra-abdominal organs may take place. In many of these cases the shock is comparatively slight, and instances are on record in which individuals have walked for a considerable distance with extensive visceral protrusions.

Treatment.—All penetrating abdominal wounds should be immediately explored under general anæsthesia, if the surgeon is in a position to conduct the operation with competent assistants under conditions of strict asepsis. Protruding viscera should be thoroughly cleansed before being returned to the abdominal cavity, and the original wound, when favorably situated, should be sufficiently enlarged to permit thorough inspection of the damaged area. If free blood or extravasated stomach or intestinal contents are seen, the wound should be extended, or another incision should be made in a more favorable locality and the source of the hemorrhage found or the wounded viscus located. The same principles should guide the surgeon in the treatment of these conditions as under other circumstances: hemorrhage should be arrested by ligature of the bleeding vessel or by gauze packing; injuries of the hollow viscera should be sutured, after which the entire peritoneal cavity should be flushed with salt solution and the wound closed with drainage. In stab wounds the injury will be limited to the immediate vicinity of the wound; in gunshot wounds the injuries are generally multiple and widely separated, and in these cases the incision should be sufficiently large to enable the surgeon to inspect thoroughly every part of the abdominal cavity. In gunshot wounds involving the stomach, the posterior wall invariably should be inspected, and in wounds of the pancreas provision should be made for adequate drainage of the pancreatic secretion. It frequently happens that the bullet will so injure the intestine that resection will be necessary. As in operations for ruptures of the viscera, the surgeon should work quickly and methodically, as prolonged exposure on the operating-table is sure to add to the shock, which in many of these cases is severe at the outset. The hypodermic injection of whiskey and strychnine, coffee enemata, and intravenous saline infusions often are necessary while the patient is on the table.

The after-treatment of these cases is of the greatest importance. Shock should be combated by judicious stimulation; food should early be administered by rectum or mouth, and pain should be quieted by some form of opiate. In cases of injury of the alimentary canal, if the symptoms are favorable, the bowels should be confined for four or five days. If peritoneal sepsis develops, early intestinal drainage by free catharsis should be induced. When the peritoneum has been severely contaminated, the surgeon should be on the lookout for signs of localized peritonitis, and collections of pus should be opened and drained as soon as discovered. If the case exhibits signs of progressive sepsis, intravenous infusions frequently repeated, rectal irrigations, free catharsis, and the administration of quinine, strychnine, whiskey, and an abundance of nourishing food will be necessary.

It frequently happens in both military and civil practice that abdominal wounds have to be treated under conditions in which perfect aseptic technic cannot be carried out. Under these circumstances small penetrating wounds, especially when produced by the modern high velocity firearms, are better left to nature, than to add the risk of an exploration under conditions of imperfect technic. In cases of severe hemorrhage and large penetrating wounds with extensive visceral injury the surgeon must act even under the most adverse conditions. Generous gauze drainage of the abdominal cavity will often assist in overcoming the infection necessarily produced in these cases.

CHAPTER XIX.

DISEASES OF THE ABDOMEN.

Cellulitis.

CELLULITIS of the abdominal wall occurs as a result of wounds, the bites of insects, and from inflammatory conditions about the umbilicus caused by infection of an unclosed urachus or vitello-intestinal duct. It also occurs as an extension outward of an intra-abdominal septic focus, reaching the surface through the inguinal canal, or by direct infiltration of the muscular layers. The symptoms and treatment are the same as in cellulitis in other parts of the body.

Congenital Umbilical Fistulæ.

Congenital umbilical fistulæ are occasionally encountered. They are of two kinds, the urinary and fæcal. The former are due to the persistence of the urachus; the latter, to a failure of complete closure of the vitello-intestinal duct which may lead direct to the intestine or to a Meckel's diverticulum. As a rule, the opening is minute and only a small amount of fluid exudes. The character of the fluid is often apparent by the odor, or it can be determined by chemical or microscopic examination.

The **treatment** of these cases should aim to effect a permanent closure of the opening. This may sometimes be accomplished by cauterization, which destroys the mucous membrane and leaves a scar which subsequently contracts and obliterates the canal. If this fails, a fine probe should be introduced into the canal, an incision made in the direction of the probe, the duct isolated and ligated with fine chromicized catgut, and the distal end cut off and cauterized, after which the cutaneous wound should be disinfected and closed with sutures. When the fistula communicates with the lumen of a Meckel's diverticulum, laparotomy and removal of the diverticulum are indicated.

Tumors of the Abdominal Wall.

Primary malignant tumors of the abdominal wall are rare. Epithelioma and sarcoma have been reported, the former generally occurring at the umbilicus, the latter growing from the muscular or fascial planes. Of the benign tumors, which are of more frequent occurrence, lipomata are perhaps the commonest, the others in the order of frequency being angiomata, fibroneuromata, dermoid and other cysts. The diagnosis and treatment of these tumors of the abdominal wall present no special features, and differ in no respect from the diagnosis and treatment of like tumors in other parts.

Johannes Müller in 1838 described a tumor of the abdominal wall which he termed a *desmoid*, and which may be said to occupy a position between the malignant and innocent growths. It is a "cellular fibroma," which occurs mostly in women who have borne children, and generally is located in the rectus muscle. It is round, ovoid, or oblong in shape; it often arises from the fibrous sheath, and occasionally has bony attachments. It grows rapidly at times and may reach the size of an orange or cocoanut. According to Pfeiffer 33 per cent. recur after operation. The treatment should be early radical removal.

DISEASES OF THE PERITONEUM.

Acute Peritonitis.

Acute peritonitis, or inflammation of the peritoneum, is, without doubt, the most important surgical disease of the abdominal cavity. It may arise from a variety of causes, and is subject to great variations in its extent, virulence, and manifestations. With our present knowledge of the pathology of the disease there is no reason to believe that it ever arises from causes other than infection of the membrane by pathogenic micro-organisms. It may therefore be caused by infection from without, as a result of penetrating wounds or surgical operations; from the alimentary canal, as from ruptures or diseases which compromise the integrity of the stomach or intestinal wall; from septic diseases of the gall-bladder or pelvic viscera; or from rupture into the peritoneal cavity of an extraperitoneal abscess or focus of infection. The disease may be limited to certain regions of the peritoneal cavity, or it may spread rapidly and eventually involve the entire extent of the membrane.

Local peritonitis may arise from a penetrating wound, from appendicitis, from salpingitis, from cholecystitis, or a small perforation of the stomach or intestine. The conditions which favor the disease remaining localized are a low degree of virulence of the infecting micro-organisms, the rapid formation of a fibrinous exudate which glues the surrounding structures together, forming an effective barrier to extension of the process, and an absence or diminished amount of peristaltic movements of the intestine.

The **symptoms** are localized pain and tenderness, nausea, fever, rapid pulse, and a general feeling of illness. On examination, the muscles over the infected area will be found rigid, and after the process has advanced to the formation of an inflammatory exudate an indurated mass may be felt, which, in the great majority of instances, consists of a well walled-off intraperitoneal abscess. This may increase in size until it occupies a large part of the abdominal cavity; or it may rupture on the surface of the body, into one of the hollow viscera, or into the free peritoneal cavity, giving rise to a diffuse peritonitis. The presence of pus in such a mass is indicated by its gradual enlargement, a continuance of the fever, the presence of a marked leucocytosis, and the occurrence of chills and sweats. Occasionally in large abscesses fluctuation may be felt through the abdominal wall, or by bimanual examinations, one finger being placed in the rectum or vagina, and the other over the abdominal tumor. In infections of a low degree of virulence it occasionally happens that the mass remains for a long time stationary, the fever, pain, and other symptoms subside, and the tumor may be mistaken for a new growth. In these cases reliance must be placed on the history and blood-count to establish the diagnosis.

Diffuse or *spreading peritonitis* begins as a localized process, and arises from the same causes as the local variety, the conditions which favor its development being a high degree of virulence of the infecting agent, the presence of a large amount of infected material in the peritoneal cavity (as in ruptures of the alimentary canal with extensive extravasations, or large accidental wounds of the parietes), active peristalsis, and a diminished resistance on the part of the individual from senility, starvation, dissipation, or disease. The streptococcus infections from wounds or from puerperal inflammations of the uterus and its appendages, the more virulent forms of Bacillus coli communis from gangrenous appendicitis or typhoid perforations of the intestine, and cases of trauma in which, in addition to the infecting agent, the peritoneal cavity contains a quantity of extravasated blood which acts as a favorable culture-medium and by its fluidity carries the infection to remote parts—are all apt to be followed by the diffuse, spreading, or generalized form of peritonitis. In this form, as a rule, there are no localizing adhesions, or if they originally existed around the primary focus, they were early ruptured or passed by the advancing inflammatory process. The peritoneum covering the intestines and other organs is injected, thickened, and covered by a fibrinous exudate, which glues certain coils together and forms adhesions with them to the walls of the cavity or adjacent organs. In other cases there is little or no fibrinous exudate, the intestines are deeply injected and the peritoneal surface is raw, blistered, and roughened. There is free fluid in the peritoneal cavity, which usually is of a thin cloudy appearance, containing flakes of fibrin, and of a foul odor; in other cases it may appear as a thin, milky fluid, or may even present the appearance of creamy pus. This fluid, if small in amount, will collect in the pelvic cavity and in the gutters on either side between the colon and abdominal wall. When the amount of fluid is large, it may distend the cavity, giving rise to the signs of ascites.

The **symptoms** of a diffuse peritonitis at first are those of a localized inflammation: nausea and vomiting, generalized or local abdominal pain, and a feeling of weakness, exhaustion, and general malaise. There are localized tenderness and muscular rigidity over the point of infection, the temperature is elevated, the pulse-rate accelerated, and the patient appears restless, anxious, and flushed. As the disease progresses the temperature rises, the pulse increases in frequency, the abdomen becomes distended, the area of tenderness and rigidity extends, and the patient seems more prostrated and septic. The bowels, as a rule, are confined; gas may be expelled at first, but at a later period is retained owing to paralysis of the intestine. When this occurs, the entire abdominal wall becomes rigid, tenderness is everywhere present, though perhaps not so readily appreciated by the patient owing to the effect of the septic absorption on the brain and nervous system. The patient lies on the back with the knees raised; the respiration is rapid and shallow owing to the pushing upward of the diaphragm by the enormous abdominal distention; the eyes are sunken; the face drawn; the mouth and tongue dry; the teeth covered with sordes. Delirium is generally present. The patient may be able to swallow and retain fluids; generally, however, vomiting is frequent, the vomited matter consisting of intestinal contents. The temperature is variable; occasionally it is high, more often it is low, and it may become subnormal. The pulse is rapid, feeble, compressible, often intermittent, and does not respond to stimulation. The urine is scanty, high colored, and albuminous. All efforts to move the bowels are unavailing. The clinical picture is strikingly characteristic, and is described best by the term *peritoneal sepsis.*

The **prognosis** in acute peritonitis depends upon many factors.

In the localized variety the outlook generally is good if the case can receive early surgical treatment. The local form of pelvic peritonitis so common in women who have been infected by the gonococcus generally results from extension of inflammation from the Fallopian tubes. It is frequently accompanied by an extensive exudate, which under appropriate treatment will often subside without suppuration. In the forms of local peritonitis following a ruptured vermiform appendix suppuration is the rule; in those following gall-bladder infections without rupture the process is usually a localized non-suppurative peritonitis, which may later cause stenosis of the pylorus from contracting adhesions. Perforating ulcers of the anterior wall of the stomach and duodenum generally give rise to a rapidly spreading fatal peritonitis, while ulcers perforating through the posterior stomach-wall give rise frequently to an inflammation limited to the lesser sac—*subphrenic abscess.*

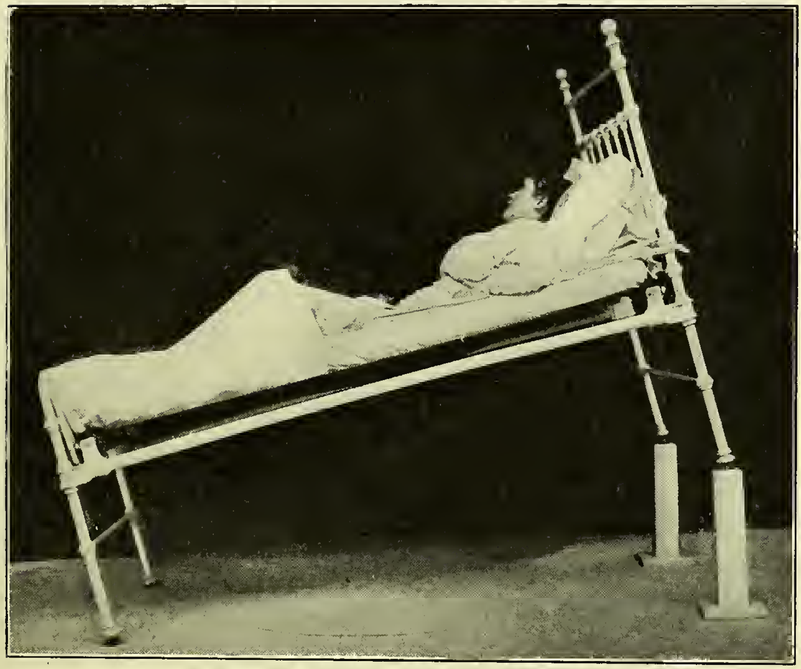
The prognosis in diffuse peritonitis from any cause is grave. Prompt surgical treatment in the early stages may occasionally be successful; but after the inflammation has invaded the greater part of the membrane and paralysis of the intestine has occurred the chances of recovery under any method of treatment are exceedingly small. A few cases may survive, children more frequently than adults.

Treatment.—With the exception of the mild cases of pelvic peritonitis in women, and the mildest forms of the other varieties of local peritonitis, all peritoneal inflammation should be treated surgically. The treatment of the *localized* form should be by incision, evacuation of the pus, and drainage, after the manner to be described under the treatment of appendicitis. In *diffuse* peritonitis the greatest difference of opinion exists. Formerly most surgeons advised large incisions, often on both sides of the abdomen, extensive handling of the viscera, wiping away the fibrinous exudate, flushing with salt solution, and the introduction of copious gauze drainage. The death-rate following these procedures was high—70 to 80 per cent. Later, surgeons began to appreciate that extensive handling of the intestines caused shock and muscular paresis, that removing the fibrinous exudate left raw surfaces which favored rapid absorption of toxins, that gauze drainage was not well borne, and that the time consumed exhausted the patient and lowered his natural resistance. One by one these heroic procedures have been abandoned, with a corresponding reduction in the death-rate. To-day most surgeons of large experience advise a small incision, quick operation with the minimum of anæsthesia and handling of the viscera; rapid removal of the primary focus, and when foreign matter is present, flushing the peritoneal cavity with warm salt solution by means of the Blake or Chamberlain tube (Fig. 214). The question of drainage must be determined by the pressure or absence of foreign or necrotic material. When employed it should be in the form of the cigarette drain, with little or no free gauze to become adherent to the intestines. When one can be sure that no necrotic material remains in the peritoneal cavity the wound may be closed with superficial drainage only, or a small cigarette drain placed just within the peritoneum. If the foreign material cannot be thoroughly removed by irrigation, a drain should be passed to the bottom of the pelvic cavity. The use of the Fowler position (Fig. 215) allows the

Fig. 214.

Blake's double-current irrigating tube.

Fig. 215.



Fowler's position for peritoneal drainage.

fluid to gravitate toward the pelvis, where absorption is slower, and where, to a limited extent, it can be carried off by the drain. As death in these cases is due largely to sepsis, every effort should be made after operation to combat the depressing influence of the poison and to promote its elimination. Thus, stimulants in the form of alcohol, strychnine, atropine, and digitalis should be freely given. Fluid in large quantities to bring about renal and cutaneous activity should be administered by the mouth or the rectum, by intravenous infusion, and by hypodermoclysis. The bowels should be moved as soon as possible by calomel, purgative salts, and the use of high enemata. Glycerine, turpentine, and castor oil, combined with soap-suds, will be found serviceable for this purpose when paresis of the bowels exists or when vomiting prevents the use of the ordinary cathartic agents. In some cases when the patient is thoroughly exhausted, and all efforts to move the bowels have failed, the use of morphine to the full physiologic effect may stop the vomiting, relieve the exhaustion, and later bring about spontaneous evacuation of the bowels. The author recently observed this effect after large doses of morphine had been administered for purposes of euthanasia. By the employment of these modern methods of treating diffuse spreading peritonitis the death-rate has been markedly reduced, and at present may be said to be between 10 and 20 per cent.

Tuberculous Peritonitis.

In tuberculous peritonitis the infection may reach the peritoneum through the circulation or from the extension of a tuberculous process in the intestine, appendix, mesenteric glands, or genito-urinary organs. It exists clinically in two forms, the *ascitic* and the *caseating.* In the ascitic variety there is a general miliary tuberculosis of the peritoneum, with the presence of a variable amount of fluid in the abdominal cavity which may be clear or more or less cloudy. In the caseating form the peritoneum in parts is greatly thickened and studded with caseating masses which vary in size from that of a miliary tubercle to that of a goose egg, or even larger. The omentum is often extensively involved, and appears as a dense cake of caseating material with or without foci of suppuration. Adhesions are frequent in this form, and when the disease is generalized all landmarks may be obliterated, and the entire abdomen, when opened, may present simply extensive masses of adherent cheesy tumors with abscesses between the coils of intestine.

The **symptoms** of tuberculous peritonitis are exceedingly variable. In the *ascitic* variety the only symptoms may be a gradual deterioration of health and the slow development of ascites. In other cases digestive disturbances may be present, with attacks of colic and constipation alternating with diarrhœa, resulting in wasting and progressive asthenia. Fever is present in the later stages, but is often absent early in the disease. In the *caseating* variety, in addition to the above symptoms, one or more irregular tumors are detected in the abdomen. These are at first movable, but later become fixed, and eventually large masses can be felt which resemble malignant disease. Areas of fluctuation may sometimes be detected and muscular rigidity is often present. The association of this disease with pulmonary tuberculosis or tuberculosis in other organs is frequent, and in the later stages is the rule. As in other forms of tuberculous disease, there is, as a rule, no leucocytosis.

The **diagnosis** of tuberculous peritonitis is not always easy. The ascitic variety may be mistaken for the ascites due to cirrhosis of the liver, or for ovarian, parovarian, and other cysts. From cirrhosis it is distinguished by the absence of other signs of cirrhosis, by the presence of one or more intra-abdominal nodules, by its slow development, and by the presence of other tuberculous deposits. From a large abdominal cyst it is to be distinguished by the fact that there is flatness in the flanks while the patient rests on the back, with resonance over the centre of the abdomen, and the flatness can be made to change its position by moving the patient on the side. In large cysts of the abdomen, on the other hand, the centre of the abdomen presents an area of flatness with resonance in the flanks, from crowding of the intestines into the lateral portions of the cavity. The caseating variety is to be differentiated from new growths of the abdominal viscera by the facts that fever is usually present, and that the tumors are, as a rule, multiple; from intra-abdominal abscesses tuberculous peritonitis is distinguished by the absence of leucocytosis. When the diagnosis is in doubt, the tuberculin test, inoculation of a guinea-pig by the fluid, or an exploratory laparotomy may be employed.

Treatment.—Experience has abundantly proved that in cases of the ascitic variety of tuberculous peritonitis, laparotomy with evacuation of the fluid and subsequent suture of the wound with or without drainage, results in cure of the disease in about 50 per cent. of the cases. The same treatment applied to the caseating form of the disease, with a limited separation of adhesions and the evacuation of abscesses if present, results in marked improvement or recovery in a smaller number of instances. The reason for this is not definitely known. Hildebrandt, from a series of animal experiments, concluded that the opening of the abdomen and admission of air resulted in a more or less prolonged hyperæmia, which exerted a curative effect upon the disease. Other experimenters have advanced the hypothesis that the operation caused the death of numerous bacilli, and that these produced an antitoxin which, by absorption, acted in the same manner as Koch's tuberculin and other similar preparations.

Yeo and other medical observers have reported large series of cases treated by non-surgical measures which also showed a recovery rate of nearly or quite 50 per cent. It is probable, as pointed out by Ochsner, that the majority of the cases treated surgically were more advanced, and had resisted treatment by purely hygienic and medical measures, and, therefore, the two classes could not with propriety be compared. The concensus of opinion at present is that all early cases should have the advantage of careful hygienic and medical treatment for a reasonable period. If not improved, they should be treated by laparotomy.

William J. Mayo strongly recommends a search for and removal of the primary focus, which, in a large number of cases, will be found in the Fallopian tubes or appendix. A failure to remove this, in his opinion, is responsible for many cases of relapse.

Chronic Peritonitis.

This term covers a variety of conditions, most of which are of purely medical interest. Among these may be mentioned: a general thickening of the membrane, accompanied by ascites and often associated with cirrhosis of the liver; localized thickening and adhesions remotely associated with the septic forms of peritonitis; and the general adhesive variety of tuberculous peritonitis which is the result of recovery from either of the two acuter forms of the disease. They are of surgical interest only when they give rise to intestinal obstruction, and will be considered under that head.

Actinomycosis of the Peritoneum.

Actinomycosis of the peritoneum may follow extension of the process from the stomach, cæcum, or appendix, or from a retroperitoneal or pelvic focus. The disease produces a thickening of the peritoneum with suppuration similar to the caseating form of tuberculous peritonitis. Sooner or later adjacent structures are invaded and the disease slowly advances to other organs and the abdominal wall. When the latter is involved, there occurs a brawny induration, with a bluish-purple discoloration of the skin, which gradually fades in the periphery of the lesion to a dull slate color. Fistulæ form and are surrounded by granulomatous tissue, making a characteristic cutaneous lesion.

The discharge is generally thin and watery, may be purulent from mixed infection, and contains the characteristic lemon-yellow granules.

Treatment.—The treatment of this condition should be by hygiene, opening and draining suppurating foci, and the exhibition of potassium iodide and the salts of copper. If the diagnosis of the primary focus could be made sufficiently early, radical removal would, of course, constitute the ideal treatment.

DISEASES OF THE STOMACH AND INTESTINES.

Foreign Bodies.

Foreign bodies which have been swallowed may lodge in the stomach or in any portion of the intestinal tube. In general it may be stated that any body which passes the œsophagus will in all probability pass through the stomach and bowels and eventually be expelled by natural processes. The swallowing of a foreign body may be accidental or intentional; the former is observed mostly in children; the latter, in the insane. Concretions may arise in any part of the alimentary canal; in the stomach, by the matting together of bits of wool or hair from the frequent swallowing of small masses; in the intestine, by formation of an *enterolith* around some foreign body, as a gall-stone.

Symptoms.—The presence of a foreign body in the stomach may produce no symptoms whatever; or it may give rise to pain, nausea, and vomiting. These symptoms are apt to come on in paroxysms, and closely resemble the gastric crises of locomotor ataxia. If the body is lodged in the small intestine near the stomach, the symptoms are similar to those of a foreign body in the stomach. The pain, however, may be localized somewhat lower. If the body lies lower down in the small intestine or in the colon, there will be more or less constant localized pain, with or without symptoms of intestinal obstruction. Coins and other metallic bodies may often be located by the x-rays. The retention of Murphy buttons after operation upon the intestines is of fairly frequent occurrence. As a rule, they produce no symptoms and the patients are unaware of their presence. Occasionally symptoms are produced which necessitate their removal.

The **treatment** of irritating foreign bodies in the stomach or intestine consists in their removal by gastrotomy or enterotomy.

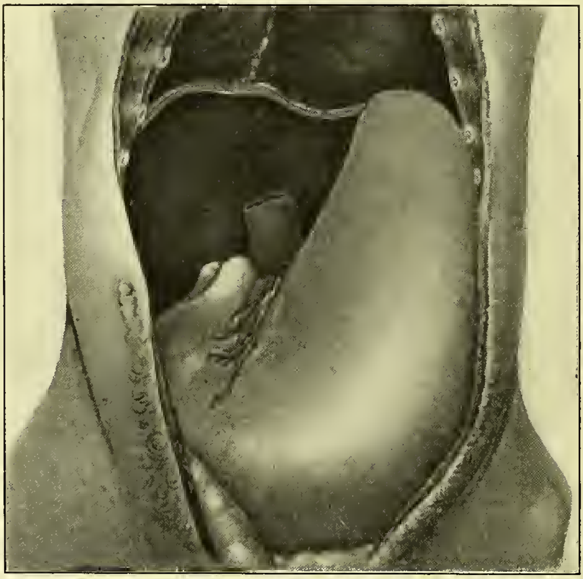
Acute Gastric Dilatation, or Gastro-mesenteric Ileus.

Hilton Fagge, in 1873, first described the symptoms of acute gastric dilatation, but it is only within recent years that the condition has been recognized as a post-operative complication.

The chief etiologic factors are a rapid dilatation of the stomach with increased secretion, later the pressure of the gastric tumor on the movable small intestines, forcing them downward, and producing thereby tension on the root of the mesentery, which in turn compresses the third portion of the duodenum against the spine and causes more or less occlusion. Kinking of the duodenum from prolapse of the distended stomach may also be a factor of importance.

As a result of the duodenal obstruction the stomach becomes enormously distended with fluid and gas, and may occupy the greater part of the abdominal cavity (Fig. 216). The primary dilatation of the stomach is probably caused by a muscular paresis from toxæmia, due to acute or chronic disease, or from surgical operation or shock. The exciting cause may be an indiscretion in diet, or the ingestion of food or water too soon after operation, before the stomach-wall has had time to regain its muscular tone.

Fig. 216.



Acute dilatation of stomach. (Conner.)

Conner states that 41 per cent. of the recorded cases followed operation.

Symptoms.—The symptoms of the condition in the order of their importance are: vomiting, prostration, and pain; the signs: distention of the abdomen, beginning in the epigastric and left hypochondriac regions, tenderness over the region of the distention, thirst, hiccough, and constipation.

The occurence after operation of persistent vomiting, a progressive distention of the abdomen from above downward, and a rapidly advancing prostration without fever or other signs of peritonitis, should at once awaken the suspicion of gastric dilatation.

Diagnosis.—The diagnosis can be established by the passage of the stomach-tube and the withdrawal of large quantities of gas and a cloudy, greenish fluid, with a sickening foul odor, but not feculent in character.

If unrecognized or untreated the progress is rapid toward a serious and often fatal exhaustion.

Treatment.—The treatment should consist in regular gastric lavage, hot stupes to the abdomen, and the hypodermic use of strychnine in large doses.[1]

Congenital Idiopathic Dilatation of the Colon (Hirschsprung's Disease).

This rare condition, as the name implies, consists of a chronic dilatation of the sigmoid and often of the greater part of the transverse and descending portions of the colon, resulting in an enormous accumulation of fæcal matter and gas.

The cause of the condition is by no means clear. Some authorities hold that it is due to a valvular obstruction in the upper part of the rectum. Others that it is due to some fault in the innervation of the gut, which results in a limited segment being without the power of peristalsis; while others ascribe the symptoms to an increase in the length of the sigmoid or its mesentery. Associated with the dilatation there is nearly always a decided thickening of the intestinal wall which involves all of the tunics.

Symptoms.—Occasionally children are born with the condition already present. In the majority of instances, however, the symptoms appear shortly after birth.

The cardinal symptoms of the condition are obstinate constipation and a progressive distention of the abdomen. The disease may advance so slowly that many cases reach adolescence or adult life before serious symptoms develop. The distention is not always symmetric, being noticed more on the left side and lower half of the abdomen. The stools are often dry and hard; sometimes soft and very offensive. Movements occur at irregular intervals, and only after repeated enemata and cathartics. Visible peristalsis can sometimes be seen. There is, as a rule, no ascites. As a result of the interference with normal nutrition, the patients are thin, anæmic, and weak. Dyspnœa, cardiac weakness, and irregularity are commonly observed when the distention is excessive and the diaphragm pushed upward.

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[1] For an interesting resumé of the subject, the reader is referred to an article by Lewis A. Conner, *Amer. Jour. of the Med. Sci.*, March, 1907.

Prognosis.—The disease is rarely fatal. In a few cases perforation has occurred with fatal peritonitis. The outlook for recovery, however, is not good unless the condition can be removed by surgical operation.

Treatment.—While patients may be kept alive for an indefinite period by the judicious use of cathartics, enemata, massage, diet, and hygienic regulations, these have absolutely no effect on the pathologic condition. Finney advises colostomy for the relief of the acute condition ; later a lateral entero-enterostomy above and below the distended portion, and at a still later period resection of the diseased area of the colon. Finney has recently reported a successful case operated upon by this method.[1]

Gastric and Duodenal Ulcer.

Gastric and duodenal ulcer, formerly thought to be rare, are now known to be of fairly frequent occurrence. Welch states that he found gastric ulcer or cicatrices in 5 per cent. of all adult autopsies. Clinical observers differ widely as to the frequency of this condition, the statistics varying from a fraction of 1 per cent. to $2\frac{2}{10}$ per cent. of all patients applying for medical treatment.

The disease occurs in three forms : First, the mucous erosion or minute bleeding point, with difficulty seen at autopsy or at operation unless actively bleeding. It is often multiple and gives rise to copious hemorrhages, but rarely to aggravated symptoms of dyspepsia. Second, the acute non-indurated, round, or peptic ulcer, most frequently observed in anæmic young women between eighteen and thirty years of age. This often bleeds copiously, gives rise to acute pain, pyrosis, nausea, and vomiting, and is generally associated with hyperchlorhydria. Third, the chronic indurated ulcer, involving all the coats of the viscus and often associated with a cicatrix on the peritoneal surface. This variety occurs with greater frequency in men between thirty and fifty, and is the lesion present in a large number of the patients who suffer for many years from intractable dyspepsia.

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[1] To Finney's classical paper on the subject the reader is referred for additional data, "Surgery, Gynæcology, and Obstetrics," June, 1908.

While the first and second varieties may give rise to severe and often fatal hemorrhage, and, while the round peptic ulcer may occasionally perforate, it is with the third easily recognized form that the surgeon has largely to deal.

This occurs with about equal frequency in the stomach and first part of the duodenum. Of the stomach ulcers, three-fourths occur at or near the pylorus. Multiple ulcers are not infrequent, and a given ulceration may pass the pylorus and involve both the stomach and duodenal mucous membranes.

Symptoms.—The symptoms of chronic indurated gastric ulcer are generally those of an obstinate dyspepsia. The typical symptoms of ulcer may for a time be preceded by those of *hyperchlorhydria,* acid eructations, moderate discomfort after meals, and a hungry, gone feeling at the pit of the stomach before meals, which is relieved by taking food.

When open ulcer is present there is epigastric pain, which appears from one-half to two hours after the ingestion of food. This pain varies from a dull feeling of weight to a severe and progressively increasing paroxysm of pain resembling gall-stone colic. At the height of the paroxysm vomiting may occur, which gives prompt relief. The vomited matter is exceedingly acid and leaves a burning sensation in the throat. Acid eructations and tenderness are generally present. Anæmia and loss of weight may occur from inanition, as the typical sufferer from gastric ulcer will starve himself rather than endure the pain of taking hearty food. Hemorrhage occurs in the majority of cases of ulcer. The amount is often so small as only to be detected by a careful microscopic examination of the stools (occult blood). In a fair number of the cases the bleeding is copious, evidenced by severe hematemesis and well-marked melena. In a small proportion of the patients it may be the immediate cause of death.

Perforation occurs in from 12 to 20 per cent. of gastric and duodenal ulcers. In the majority of instances the perforation occurs on the anterior surface, is accompanied by extravasation of the highly acid gastric contents, and gives rise to a rapidly spreading septic peritonitis. In a small number of cases the perforation is minute and quickly sealed by a fibrinous exudate, or the peritonitis is limited by protecting adhesions. As a result of œdema, the gradual development of cicatricial tissue, peritoneal bands, adhesion to other organs, pyloric stenosis occurs in a large number of these patients. This results in a gradual dilatation of the stomach, diminished motility, and fermentation, the symptoms of which will be described in the next section. Hourglass stomach is a rare complication.

Prognosis.—The statistics of Greenough and Joslyn, based upon an analysis of 187 cases of gastric ulcer treated medically at the Massachusetts General Hospital, show that while 80 per cent. were discharged as cured and only 8 per cent. died, subsequent inquiry made several years later showed that only 40 per cent. remained well, and that 20 per cent. had died as a result of the disease. In other words, 60 per cent. of the victims of chronic gastric ulcer treated medically must look forward to death or a life of chronic invalidism. Statistics from the best modern surgical clinics show that the same class of cases treated surgically give a death-rate of less than 5 per cent. and upward of 70 per cent. of permanent cures. The prognosis of primary hæmatemesis is generally favorable. Repeated hemorrhages, however, constitute a bad prognostic sign. The prognosis of perforation varies with the time which has elapsed between the accident and the laparotomy. In cases under twelve hours the outlook is favorable; beyond that period the mortality increases with each hour of delay. It is now pretty generally admitted that gastric ulcer is one of the most, if not the most, important cause of cancer, Mayo reporting that upward of 50 per cent. of gastric cancers removed at the Rochester clinic show unmistakable evidence of having developed upon ulcer.

Treatment.—Gastric or duodenal ulcer without pyloric stenosis or other complications should be subjected to intelligent medical and dietetic treatment for at least six weeks. If not relieved by this treatment, or if there is a strong tendency to recurrence after a medical cure, operation should be advised.

In indurated ulcer at or near the pylorus Rodman advises pylorectomy on account of the strong tendency of such lesions to degenerate into cancer. Under favorable conditions the mortality should not be much above that of gastro-enterostomy, and the writer advises it in otherwise healthy individuals after a fair statement of the risks. Gastro-enterostomy is, however, the operation of choice in the great majority of cases of chronic ulcer. It is also to be recommended in all cases of recurrent or persistent hemorrhage from ulcer.

It should also be performed in those cases of perforation where suture of the wound causes stenosis, and in other cases where the operation is an early one, before peritonitis has had time to develop.

Ulcers of the Bowel.

Ulcers of the bowel below the duodenum may be caused by typhoid fever, dysentery, tuberculosis, syphilis, actinomycosis, intestinal obstruction, or by the presence of foreign bodies, enteroliths, or fecal concretions. These rarely come under the care of the surgeon unless perforation occurs.

Typhoid perforation of the intestine occurs in a considerable number of cases, about one-third of the deaths being due to this complication. According to Haggard's statistics, it occurs most frequently in the third week of the disease, although cases have been reported as early as the first and as late as the fourteenth week. In over 95 per cent. of the cases the lesion occurs in the ileum, generally within eighteen inches of the cæcum. The lesion is usually single, and generally is found to be a small pin-point perforation on the surface opposite the mesenteric attachment. Occasionally several perforations are present. The perforation usually is surrounded by an infiltrated area which is exceedingly friable, and this condition frequently renders closure by sutures difficult.

Symptoms.—The symptoms of perforation in typhoid fever are often obscure, and are masked by the symptoms peculiar to the disease. The evidences at first are those of peritoneal irritation, pain, tenderness, and muscular rigidity. At a later period the symptoms are those of a spreading peritonitis, pain, vomiting, increased tenderness and rigidity, meteorism, and a rapidly progressive prostration. Leucocytosis may be an early symptom, and is generally present after peritonitis develops. The presence of free fluid and gas in the peritoneal cavity is conclusive evidence of perforation, but these signs are rarely observed in the early stage. A sudden fall in the temperature and rise in the pulse rate is significant, and when combined with symptoms of peritoneal irritation is strong confirmatory evidence of a perforative lesion.

Prognosis.—The prognosis in untreated cases is exceedingly bad, the death-rate, according to Murchison, being from 90 to 95 per cent. By timely operation from 25 to 30 per cent. of the cases can be saved.

Treatment.—While the condition of a typhoid patient with perforation of the intestine is always such as to render any surgical operation extremely hazardous, immediate laparotomy, closure of the intestinal wound, and cleansing the peritoneal cavity, are positively indicated in all cases seen sufficiently early, and in which the physical condition is not so grave as to contraindicate the administration of an anæsthetic. A thorough operation performed with the maximum of speed and the minimum of anæsthesia and exposure, combined with the judicious use of stimulants, especially the intravenous infusion of saline solution, will occasionally save a patient even under conditions which seem most unfavorable.

Dysenteric ulcerations of the large intestine rarely perforate, but they frequently prove fatal by the exhausting diarrhœa and hemorrhage which they provoke, as well as by the hepatic suppuration which sometimes follows.

Treatment.—After all reasonable medical measures have been tried, a right-sided colostomy, with frequent irrigation and rest of the colon, may bring about cure. Complete extirpation of the colon has successfully been performed by Lilienthal for chronic hemorrhagic colitis which had resisted all other treatment.

Tuberculosis of the Gastro-intestinal Tract.

Gastric Tuberculosis.—Tuberculosis of the *stomach* is an exceedingly rare disease. It is generally associated with tuberculosis of the lungs and other organs.

Symptoms.—The symptoms are those of chronic ulcer, and the diagnosis is established by the demonstration of tubercle bacilli in the stomach contents.

Tuberculous ulceration of the *bowel* is of more frequent occurrence than that of the stomach, but it is generally secondary to tuberculosis elsewhere, and belongs rather to the domain of internal medicine.

Ileocæcal Tuberculosis.—Hartman and Pilliet, in 1891, called attention to a form of *hyperplastic tuberculosis of the intestine* resulting often in tumor formation and stenosis.

While this condition may occur in any part of the small or large intestine, in over 80 per cent. of the cases it involves the ileocæcal region. In these cases there is a diffuse infiltration of the cæcal wall, which generally extends to the ileum and appendix. The mass grows slowly, often without symptoms at first, and not infrequently is mistaken for a neoplasm.

Symptoms.—The symptoms of ileocæcal tuberculosis are, in the beginning, those of an indefinite digestive disorder; moderate pain and tenderness, diarrhœa, and loss of appetite and weight. Later, as stenosis develops, the pain is of a colicky character and is often referred to the umbilical region. Still later, pain and tenderness in the right iliac fossa suggest the diagnosis of chronic appendicitis. When a palpable tumor is present, carcinoma or sarcoma often is suspected.

The disease occurs most frequently in individuals between twenty and forty years of age. In doubtful cases the tuberculin reaction is of value.

Treatment.—As the disease produces stenosis in the majority of instances, complete extirpation of the diseased area is to be advised. This, in most cases, is best accomplished by a two-stage operation : the first consisting of an ileocolostomy ; the second, an extirpation of the diseased area. The mortality of the operation carried out in this manner, in suitable cases, is not over 12 per cent.

Actinomycosis of the Intestine.

As stated elsewhere, in about 50 per cent. of the cases of intestinal actinomycosis, the lesion is located in the ileocæcal region. The disease resembles, in its early stages, the hyperplastic type of tuberculosis. There is a massive infiltration of the intestinal wall, which later extends to the abdominal parietes, producing a brawny induration, with fistulæ.

The *diagnosis* is established by the presence in the discharges of the lemon-yellow granules, made up of the actinomyces. The treatment has been already described.

Pyloric Stenosis.

Pyloric stenosis results from extensive ulceration and thickening, from cicatricial contraction of the orifice, from peripyloritis, from new growths, and from spasm. Pyloric stenosis also occurs as a congenital lesion, the cause of the obstruction in these cases being an enormous hypertrophy of the circular muscular fibres. As pyloric stenosis is most frequently associated with ulcer or carcinoma, its early recognition is of the greatest importance.

The results of pyloric obstruction are the gradal devuelopment of a dilated stomach, with or without atony of its muscular structure, retardation of the outward passage of food into the intestine, acid fermentation, and subacute gastritis. The stomach may reach an enormous size, and by its weight may drop downward when the patient is erect, so that the lesser curvature lies two or more inches below the ensiform cartilage and the greater curvature may reach the symphysis pubis (gastroptosis).

The **symptoms** of pyloric stenosis are those of a dilated stomach. There is more or less constant epigastric discomfort, with nausea, a foul tongue, and offensive breath. As only a small quantity of the food taken passes into the intestine, and as little is absorbed from the dilated stomach, the patient rapidly loses flesh and strength, the bowels are constipated, the urine scanty, the skin dry, and the mind apathetic. Vomiting is the most characteristic symptom. It occurs at irregular intervals and is often copious; in severe cases two or three quarts may be expelled. The vomited matter is made up of a mixture of partly digested food suspended in a foul-smelling, dirty gray fluid containing lactic and butyric acids and other products of decomposition. It often happens that food taken a day or two previously can be recognized in the vomitus. In congenital pyloric stenosis the infant vomits frequently and shows a progressive loss of weight. A small amount of food may be retained, but if an ordinary feeding is given, it is quickly rejected. The infant apparently suffers from hunger, cries constantly, and soon presents the appearance of rapid starvation. After a feeding, visible peristaltic waves may be seen through the attenuated abdominal wall. A palpable tumor is present in about one-third of the cases.

A rare form of pyloric stenosis, presumably due to spasm and associated with hypersecretion, is described as *Reichman's disease*, the symptoms of which are intermittent attacks of prolonged and exhausting vomiting.

In the **diagnosis** of dilatation of the stomach the physical signs are of great importance. By inspection the outlines of the greater and lesser curvatures are often clearly projected upon the abdominal wall; and peristaltic waves may be seen passing from the fundus to the pylorus or in the reverse direction.

By palpation one may elicit an abnormal splashing, of wide extent, at a time when the normal stomach should be empty. A dilated stomach when distended by gas affords a uniform elastic resistance like that of an air-cushion.

By percussion, in the erect posture, a line of flatness can be determined, which corresponds to the level of fluid in the dependent part of the greater curvature. If now more fluid be swallowed, the upper level of flatness will be found at a higher plane. If the patient be placed in the dorsal position, or if the fluid be removed by the tube, the flatness will give place to resonance.

When the stomach-tube is passed far enough to be arrested by the greater curvature, the length of tube beyond the incisor teeth may reach twenty-eight inches or more; whereas the length for a normal stomach scarcely exceeds twenty-four inches. If the stomach be inflated with air, by means of the rubber bulb of an atomizer attached to the stomach-tube, or by the liberation of carbonic acid gas, after swallowing separately solutions of tartaric acid and sodium bicarbonate, the examination by inspection and percussion will be greatly facilitated. The capacity of the organ may also be estimated by measuring the maximal quantity of water which can be introduced through the tube and again recovered by immediately siphoning off. Sometimes it is difficult to distinguish between dilatation of the colon and that of the stomach; but a decision may be reached by distending one organ with water and the other with gas.

If the gastric dilatation be due to a pyloric carcinoma, which has not developed from the margins of an older ulcer, it will generally be found that free hydrochloric acid is absent or present only in traces; or that combined hydrochloric acid is present alone, while lactic acid is easily recognizable. Absence of hydrochloric acid with presence of lactic acid is not pathognomonic of carcinoma; it indicates necessarily only pyloric obstruction, gastric dilatation, stagnation of the stomach-contents, and secretory inability; but carcinoma of the pylorus is by far the commonest cause of these associated conditions.[1]

In addition to the tests mentioned in the foot-note, it is well to search for red blood-cells with the microscope and to test for hæmoglobin chemically. In rare instances small particles of carcinomatous growth may be recognized by the microscope.

When hydrochloric acid is absent and lactic acid present, particularly in cases of carcinoma, there will often be found myriads of large, slender bacilli which stain brown with Gram's iodine solution. These "Boas-Oppler" bacilli are quite suggestive of carcinoma.

The **treatment** of this condition consists in surgical procedures which enlarge the pyloric orifice, or those which, by establishing a new outlet, sidetrack the obstruction and allow the organ to regain its normal tone. The former may be accomplished by pyloroplasty and pylorectomy; the latter, by gastro-enterostomy, soon to be described. In congenital stenosis, gastro-enterostomy is the method of choice, although the mortality is necessarily high. Bunts recently reported a series of 69 cases treated by gastro-enterostomy with a mortality of 53 per cent.

Cardiospasm.

A rare disease, probably of nervous origin, giving rise to spasmodic closure of the cardiac sphincter and retention of food in the œsophagus. If the spasm continues, a compensatory hypertrophy of the muscular coats of the œsophagus occurs, which for a time prevents the development of other symptoms. Sooner or later, however, if the spasm is not relieved, dilatation of the œsophagus results, with retention of food and regurgitation.

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[1] In order to examine chemically the gastric contents, the stomach should be cleansed by lavage and a test-breakfast given, consisting of a dry roll without butter and a pint of tea without cream or sugar. At the end of one hour the stomach is emptied through the tube and the contents tested for free hydrochloric acid by means of congo-red paper, or phloroglucin and vanillin, or dimethyl-amido-azo-benzol. If free hydrochloric acid be present, its amount should be estimated by titration with $\frac{1}{10}$ normal sodium hydroxide solution, using dimethyl-amido-azo-benzol as an indicator. If the dilatation be due to a recent ulcer, hyperacidity is often found. If free hydrochloric acid be absent, one should determine the combined hydrochloric acid. This is done by two separate titrations: first, using phenolphthalein as an indicator, the result representing the total acidity due to free hydrochloric acid, combined hydrochloric acid, organic acids and acid salts; second, using alizarin as an indicator, the result representing the total acidity minus the combined hydrochloric acid. If now the second result be subtracted from the first, one has an expression of the acidity due to hydrochloric acid in albuminous combination. If hydrochloric acid be absent, it it essential to test for the presence of lactic acid by extracting the gastric contents with ether, dissolving in water and adding ferric chloride, a positive result yielding a bright yellow-green color.

Symptoms.—The symptoms are at first only a choking sensation, moderate substernal pain, and a feeling that food is arrested in the gullet. The attacks may last for several days and be relieved spontaneously as a result of vomiting. When dilatation occurs, there is a constant substernal pain and distress with frequent regurgitation of undigested food which is alkaline in reaction. Wasting, thirst, and scanty urine are late symptoms.

Treatment.—The treatment should consist in gradual dilatation by œsophageal bougies when this is possible. If the bougies are arrested at the cardiac orifice, Plummer recommends the swallowing of three yards of silk thread, and later the passage of a special olive-pointed bougie which is perforated at the tip for the passage of the thread. In other cases he employs an ingenious dilating rubber bag attached to the end of a bougie, which is distended by water pressure.[1]

Hour-glass Stomach.

Hour-glass stomach is a cicatricial contraction of the walls of the stomach near its middle which divides the organ into two portions connected only by a narrow opening. This condition may result from healing of an extensive ulceration, from perigastric adhesions due to localized peritonitis from a small perforation, or rarely from malignant disease.

If the obstruction is located near the pylorus, the symptoms may resemble those of pyloric stenosis; if near the middle of the stomach, they may differ in that the patient is able to take and retain only a small amount of food from the diminished capacity of the organ. Pain is usually present, and malnutrition is frequently the most important symptom. In many cases a tumor can be felt which strongly resembles carcinoma. A symptom observed by the author in a well-marked case was absence of visible gastric dilatation after the introduction of air by a bulb syringe or after the swallowing separately of sodium bicarbonate and tartaric acid. The reason of this was apparent on opening the abdomen, when it was found that the contracting bands divided the stomach near its centre, the cardiac portion, which would chiefly be dilated by the gas, lying wholly beneath the left costal arches.

Treatment.—Three methods of treating this condition have been suggested: *gastroplasty*, or making a longitudinal incision through the scar and uniting it transversely, thus enlarging the opening as in pyloroplasty; *gastrogastrostomy*, or establishing an artificial opening between the two dilated portions of the stomach; and *gastro-enterostomy*, or uniting the jejunum with the cardiac pouch.

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[1] For a fuller description of these methods the reader is referred to Dr. Plummer's excellent paper in the "Journal of the American Medical Association, May 13, 1908.

Peripyloritis.

Peripyloritis is a condition in which there are adhesions between the pylorus and the anterior abdominal wall, the gall-bladder, the liver, or the colon, caused by a localized peritonitis from a perforation of the stomach or duodenum, or by extension of an inflammation from an infected gall-bladder.

The **symptoms** of peripyloritis may be those of pyloric stenosis, portal congestion, common duct obstruction, or simply localized pain.

The **treatment** is by laparotomy with separation of the adhesions.

Carcinoma of the Stomach.

Next to the uterus and female breast, the stomach is the most frequent seat of primary carcinoma. It occurs in four forms, which in the order of their frequency are the cylindric-cell epithelioma, the encephaloid, the scirrhous, and the colloid. Cancer affects the pylorus and lesser curvature in more than two-thirds of the cases. It is rarely limited to the anterior or posterior wall or the greater curvature. It is of fairly frequent occurrence at the cardiac orifice. The disease occurs late in life. Cylindric-cell epithelioma and scirrhus are generally of slow growth, and are hard and firm to the touch. The encephaloid variety grows faster and is softer in consistence, it ulcerates early, and hemorrhage is frequently abundant.

Colloid cancer involves all the coats of the stomach at an early date, and often spreads to neighboring organs and tissues. Extension of the disease follows, as a rule, the lymphatic channels; thus in pyloric growths and those along the lesser curvature the lymph-nodes in the gastrohepatic omentum are first involved, while in growths of the greater curvature those lying between the two layers of the great omentum are enlarged. At a later period the supraclavicular and inguinal lymph-nodes rarely are invaded. Direct extension of the disease to the liver is not infrequent, and occasionally enlargement of the liver and other hepatic symptoms are noticed before the stomach-lesion is recognized.

The **symptoms** of gastric cancer may for a long time be extremely obscure. In not a few instances the patients present only symptoms of general ill health, with progressive anæmia and loss of flesh and strength. In most cases, however, there is a history of impaired digestion, with a certain amount of pain, nausea, and vomiting. These symptoms occur more frequently after taking food, although the vomiting may be irregular or absent in cases of cancer limited to the anterior or posterior wall of the organ. In pyloric cancer the vomiting occurs one or two hours after taking food; in cancer of the cardiac orifice, at a much earlier period. Except in the encephaloid variety, hemorrhage is rarely profuse. It is frequently present, however, and appears as a black "coffee-ground" mass in the vomited material.

The presence of a palpable tumor in the epigastric region, while frequently detectable in the later stages of the disease, is not an early sign, for the reason that the growth of the tumor is slow, and it rarely reaches a size to render its recognition easy until other symptoms render the diagnosis certain. Moreover, only a small portion of a stomach is accessible to palpation, as two-thirds or more of this organ lies beneath the ribs on the left side. When felt, the tumor is usually hard and nodular, and moves at first with respiration. At a later period it may become fixed from adhesions to the deeper parts. Occasionally a dilated stomach may be seen on inspection, presenting peristaltic waves moving from left to right. In the later stages of the disease there is increased pain, copious vomiting of a foul-smelling material containing food remnants, rapid wasting, progressive prostration, and a dry sallow skin. The stomach finally rejects all food, the patient becomes bed-ridden and dies from hemorrhage, starvation, or exhaustion from profound cachexia.

Pyloric cancer produces gastric dilatation with the characteristic symptoms; cancer of the cardiac orifice produces atrophy of the stomach with enormous dilatation of the œsophagus. Cancer involving the body of the organ without encroaching upon either orifice may exist for months without producing any characteristic symptoms.

Diagnosis.—Viewed from a standpoint of surgical treatment, it is of the utmost importance that cancer of the stomach should be recognized at the earliest possible moment, for it is only at this period that radical treatment holds out any chance of success. The occurrence of dyspeptic symptoms with loss of flesh and anæmia in an individual over forty years of age, or a distinct aggravation of a previous digestive disturbance, should always awaken the suspicion of cancer. If to this are added evidences of decreased motility of the organ, with an absence of free hydrochloric acid, exploratory laparotomy for purposes of diagnosis and treatment is justifiable if the patient wishes to avail himself of the advantages of an early radical operation. Gastric ulcer can generally be excluded by the age of the patient, the less frequent but more profuse hemorrhage, the more violent attacks of pain, hyperacidity, and the fact that the disease may last for many years without loss of weight and strength and with periods of distinct improvement in the general nutrition and anæmic condition, between attacks of hemorrhage. Atonic gastritis may show an absence of hydrochloric acid, the digestive disturbances, the loss of weight and strength, the anæmia, but rarely the cachexia. Moreover, the progress of the disease is much slower.

Prognosis.—The disease, unless radically removed at an early period, is invariably fatal, death occurring in from one to two years after the first characteristic symptoms. The interest awakened by the increasing number of cures by early and radical operative measures, which have been reported during the past few years, has led to more careful methods of examination and earlier diagnosis. As a result of this, many cases are now subjected to operation at a more favorable period, and surgeons confidently look forward to better statistics in the near future. In late cases life often can be prolonged and suffering relieved by certain palliative surgical measures, as gastrostomy and gastro-enterostomy.

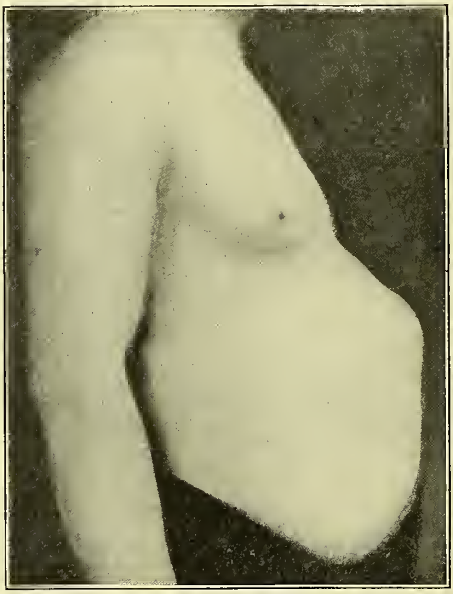
Treatment.—As soon as the diagnosis is established or rendered even probable, it should be decided which method of treatment is to be followed, the radical or the palliative. Radical treatment by early removal of the growth is indicated in the primary stages of the disease before wasting or marked anæmia has occurred, and when there is reason to believe that the disease can be thoroughly eradicated. This, of course, can only be determined by an exploratory operation. Enlarged lymph-nodes may be due to septic absorption from a malignant ulcer, and should not deter the surgeon from radical operation if other conditions are favorable. Carcinoma of the pylorus should be removed by pylorectomy. If the disease involves the body of the organ, gastrectomy, partial or complete, is indicated. Neither of these operations should be attempted if there is extensive lymphatic metastasis, adhesion to other organs, or if there is marked anæmia or cachexia.

If the palliative method of treatment is to be followed, the patient should be placed in the most favorable hygienic surroundings, should have an abundance of easily digestible, nourishing food, and if the stomach is irritable or there is evidence of diminished motility, with dilatation and fermentation, lavage should be practised daily. Gastro-enterostomy should be performed on cases of pyloric stenosis, gastrostomy when the cardiac orifice is involved. The technic of these operations will be described in another section.

Sarcoma of the Stomach.

Sarcoma of the stomach is a rare disease. According to W. S. Fenwick, it is present in from 5 to 8 per cent. of all malignant growths of the organ. Two forms are described, the small round-cell or lymphosarcoma, a rapidly growing and exceedingly malignant tumor, and the spindle-cell variety or fibrosarcoma, a slower developing and less malignant growth. The disease occurs at an earlier age than carcinoma, the majority of cases developing in women between thirty and forty years of age. The disease resembles carcinoma in that there are early digestive disturbances, localized pain, hemorrhage, and vomiting, with rapid loss of flesh and strength and progressive anæmia. If differs from carcinoma in that the tumor grows faster and reaches a greater size; it is more movable, and is frequently associated with enlargement of the spleen, fever, general purpura, and the presence of small cutaneous sarcomatous nodules around the umbilicus. In lymphosarcoma no surgical treatment is to be recommended, as the growth progresses rapidly to a fatal termination, and when the disease is sufficiently far advanced to admit of a positive diagnosis it has passed beyond the possibility of surgical relief. Fibrosarcoma should be treated in the same manner as gastric carcinoma.

Fig. 217.



Sarcoma of the stomach.

Intestinal Obstruction.

Intestinal obstruction may be caused by any condition which prevents the normal outward movement of the intestinal contents; hence it may be due to paralysis of the bowel from acute peritonitis, to strangulated hernia, to strangulations within the abdominal cavity, to intussusception, to the lodgement of foreign bodies, to impaction of solid feces, to the presence of twists or kinks of the bowel, to new growths, to cicatricial contractions following ulceration, and to the outside pressure of tumors.

In this section, however, those forms only will be considered in which intra-abdominal mechanical obstruction constitutes the chief factor, obstructions from septic peritonitis, external hernias, or rectal diseases being considered elsewhere. In this connection the term *obstruction* signifies occlusion only; *strangulation*, on the other hand, signifies not only occlusion of the gut, but also pressure on the bloodvessels, cutting off the circulation to the part, and leading to gangrene. The symptoms of strangulation are much more acute than those of obstruction.

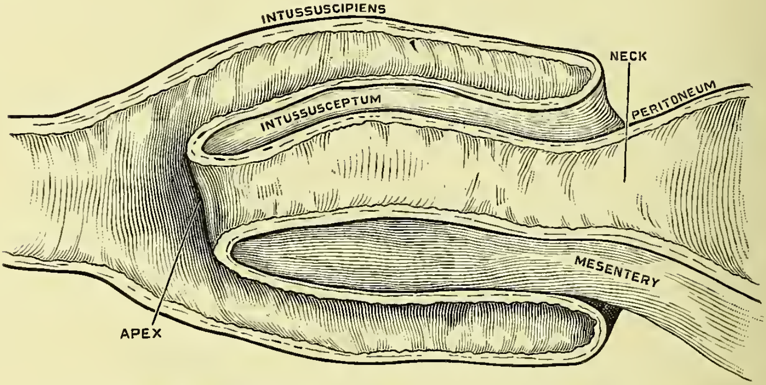
Acute intestinal obstruction, according to Fitz, is most frequently caused by *constriction of the bowel by bands or adhesions* resulting from previous inflammatory processes, from fœtal structures (as a Meckel's diverticulum which is connected with the mesentery or abdominal wall by means of a fibrous cord), from incarceration of a portion of the intestine in one of the peritoneal fossæ (duodenojejunal, subcæcal, or subsigmoid), through a rent in the mesentery following a surgical operation, or through a narrow opening created between two layers of the mesentery caused by adhesions from caseating tuberculous glands.

Next in frequency comes *intussusception*, in which one portion of the intestinal tube is pushed into an adjacent portion by violent peristalsis (Fig. 218). This condition is observed most frequently in children, and may be due to diarrhœa, to the presence of a foreign body or a tumor within the lumen of the gut. The most frequent seat of the primary invagination is at the ileocæcal valve. This immediately may be carried upward into the colon, drawing after it more or less of the ileum, or the ileum may be at first pushed through the valve, dragging the ileocæcal valve and cæcum upward at a later period. The first variety is called *ileocæcal* intussusception; the second, *ileocolic*. The former is the commonest form of the disease, the latter the rarest. Between these two in point of frequency come the *enteric* variety and the *colic;* in the former the lesion is confined to the small intestine, in the latter to the colon.

Volvulus, or a twist of the intestine on its mesenteric axis sufficient to cause an obstruction of its lumen and a strangulation of the mesenteric vessels, is third in point of frequency. This occurs generally in middle-aged men, and in more than one-half the cases is found in the sigmoid flexure; the region of the cæcum is next in frequency, and the small intestine third.

Foreign bodies occasionally give rise to acute obstruction. They may exist for some time in the bowel, producing more or less indefinite symptoms, but give rise to acute stoppage only when they become lodged in certain narrow regions, as at the ileocæcal valve. Foreign bodies which have been swallowed, masses of intestinal worms, large gall-stones which have ulcerated through from the gall-bladder into the small intestine or colon, and enteroliths made up of fecal concretions or other foreign bodies enlarged by a deposit of the phosphates of lime and magnesia, are among the commonest foreign bodies found under these conditions.

Fig. 218.



Showing relations of the component parts of an intussusception.

The **symptoms** of acute intestinal obstruction are pain, vomiting, obstipation, abdominal distention, and marked prostration. The pain may be colicky or constant; the former in incomplete obstruction, the latter in complete; it is generally referred to the region of the umbilicus, and may become intense. The vomiting is perhaps the most characteristic symptom. At first the stomach-contents are rejected, then bile, and finally intestinal matter. While the contents of the lower bowel are frequently expelled either spontaneously or as a result of an enema, no free movement from above takes place, and the abdomen gradually swells from the accumulation of gas which results from fermentation of the intestinal matters confined above the obstructed area. This fermentation also develops highly toxic substances, which by their absorption give rise to the progressive asthenia and shock which always accompany this condition. The pulse is small, rapid, and irregular, the temperature is subnormal, the skin is cold and moist, the face drawn and anxious, the eyes sunken, the circulation impeded, hiccough occurs, and the patient unless speedily relieved gradually passes into a condition of fatal collapse. When the obstruction is situated high up in the small intestine distention may be absent. The vomiting, however, is severe and exhausting, and the urine is scanty, high colored, and contains a large amount of indican. If life is sufficiently prolonged, necrosis of the gut may occur with perforation, giving rise to septic peritonitis. This condition is evidenced by abdominal tenderness, muscular rigidity, and fever. When it occurs late in the disease, the reaction is slight and often transitory, the only indication being perhaps a more rapidly developing toxæmia. As these cases are frequently seen by the surgeon only after considerable delay, it is often impossible to make a more specialized diagnosis than to affirm that obstruction of some kind exists. Certain facts, however, suggest the probable existence of one or the other of the usual varieties. Thus, a history of previous peritonitis in an adult, or a recent abdominal section, would suggest strangulation by a band of adhesions; a gradually developing sausage-shaped tumor in the region of the colon in a child with bloody stools, or the presence of a protruding mass in the rectum, would warrant the diagnosis of intussusception. Acute sudden pain and tenderness in the left inguinal region in an adult with the classic symptoms of obstruction would lead one to think of volvulus; while the presence of a localized, hard, movable tumor in the region of the cæcum or sigmoid would point to a foreign body.

Treatment of Acute Obstruction of the Bowel.—This should invariably be surgical, and should be instituted as soon as the diagnosis is made. Distention of the colon with gas or water in a case of suspected early intussusception may be tried while the patient is being prepared for operation, but prolonged attempts should be discouraged, as they tend only to weaken the patient and render him less able to bear the strain of operation.

When there are distinct localizing signs the incision should be made in such a region as best to expose the seat of obstruction. If there are no such signs, a median incision should be made and the transverse colon first found and examined (Murray). If this is distended, the obstruction should be sought for in the descending colon or sigmoid; if the transverse colon is collapsed and the small intestine distended, the obstruction will probably be found at the cæcum or in the small intestine. When the point of obstruction is reached, it should be relieved as quickly as possible, and the abdominal wound closed with through-and-through silk-worm gut sutures. If the obstruction is caused by strangulation or by incarceration of a loop in a peritoneal pouch or mesenteric opening, the bands should be divided or excised, the adhesions separated, the incarcerated loop of intestine relieved, and the opening closed by sutures to prevent recurrence. If the strangulated gut is gangrenous, it should be resected and the bowel united with a Murphy button or by one of the other methods of intestinal anastomosis to be described later. If there is doubt regarding the vitality of the intestine, the diseased loop may be drawn out of the abdomen and surrounded with gauze, leaving the question of replacement or enterectomy to be determined at a later period.

If intussusception is present, it should be reduced by manipulation or manipulation aided by the pressure of water introduced into the colon, the patient being in the Trendelenburg posture. If this fails, the intestine should be opened by a longitudinal incision, the invaginated mass removed, and intestinal anastomosis made by the Maunsel method, to be described at the end of this section. Clubbe advises a forcible oil enema after the child is under the anæsthetic ; this to be immediately followed by laparotomy and taxis. This plan he believes greatly reduces the number of cases requiring resection. Kredel and Codman have recommended enterostomy in irreducible cases, combined with ligation of the mesenteric arteries supplying the intussusceptum, with a view to favoring rapid sloughing and discharge by the rectum. After the gangrenous mass is cast off the enterostomy wound should be closed.

In case of volvulus the bowel should be untwisted; in case of a foreign body in the intestine it should be moved backward if possible by manipulation and removed by incision through a healthy part of the gut. In many instances it happens that the condition of the patient will not admit of prolonged surgical manœuvres, and it is often necessary to withdraw a loop of small or large intestine as close above the point of obstruction as possible, and create an artificial anus, thus relieving the obstruction and allowing the patient to recover from the extreme toxæmia, after which a subsequent operation may be undertaken to remove the cause and close the artificial opening.

Chronic intestinal obstruction is due to a slowly developing narrowing of the intestinal tube, as a stricture resulting from the healing of an ulcer, or the growth of an innocent or malignant tumor within the lumen of the bowel or infiltrating its wall; to outside pressure of tumors, bands, or adhesions; to the impaction of feces; or to the presence of foreign bodies.

The **symptoms** of chronic obstruction are exceedingly variable. There is usually a history of a progressively increasing constipation. At a later period there may be attacks of acute transitory abdominal pain, with more or less distention and possibly vomiting. These are of comparatively short duration, and are generally relieved promptly by active purgation. As the disease advances, these attacks of more or less acute obstruction become more frequent and are relieved with greater difficulty, and between the attacks only a small amount of fecal matter passes. The abdomen gradually distends, eructations of gas occur, anorexia and nausea become prominent symptoms, the patient loses flesh and strength, and pain and discomfort in the abdomen become constant. The acute attacks are now characterized by severe pain and obstinate vomiting, which may be prolonged and exhaust the patient. There is usually a terminal acute obstruction, in which the patient dies unless relieved by prompt surgical intervention.

Chronic obstruction when due to bands or adhesions is generally preceded by an attack of peritonitis or some abdominal operation. When due to strictures there is usually an early history of ulceration. In fecal impaction there is usually to be felt an elongated tumor over the region of the sigmoid or left colon, which pits on pressure and may be felt also by rectal examination. It occurs generally in adult women, and the mass may be tunnelled, allowing a certain amount of liquid matter to pass each day with more or less effort and tenesmus. Vomiting and pain occur, if at all, at a late period. Tumors within the lumen of the gut are rarely made out by palpation. Enteroliths and foreign bodies may sometimes be felt, and are occasionally seen by the x-rays. Carcinoma produces obstruction before the tumor can be felt. Sarcoma produces a recognizable tumor, generally without obstruction at first, as it grows eccentrically and does not narrow the lumen of the gut, but may produce obstruction later by pressure.

Treatment.—Except in cases of fecal impaction, which should be relieved by high ox-gall and sweet-oil enemata, cathartics, and mechanical removal of the mass from the rectum; all cases of chronic intestinal obstruction should be treated surgically, for although the symptoms may not at first be urgent, most of the conditions enumerated above as the causes of chronic obstruction are progressive, and it is desirable to operate at a period when removal of the obstruction can be effected with the least possible danger. Early exploratory laparotomy is, therefore, to be advised when there is reason to believe that mechanical obstruction of the bowel exists. A stricture may be enlarged by making a longitudinal incision into the bowel through the cicatricial band and uniting it transversely by Lembert or Halsted sutures; or the strictured area may be excised and the ends united with a Murphy button or by any of the other methods of end-to-end anastomosis. Tumors of the bowel or of adjacent organs pressing on the bowel should be removed if possible, and bands and adhesions separated sufficiently to liberate the incarcerated intestine. In the presence of chronic diffuse adhesive peritonitis, such as frequently follows the acute septic or tuberculous variety, little can be done, as the obstruction is often dependent on many points of narrowing and kinking of the intestine which cannot be removed without fatal injury to the parts.

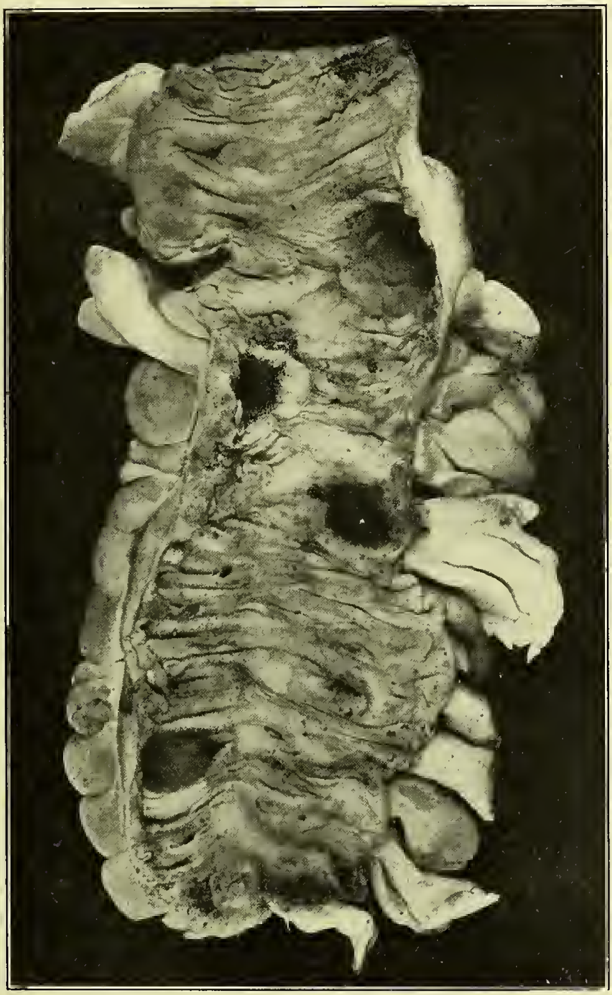
If after an exploratory laparotomy the source of the obstruction is found to be impossible of removal, two methods may be employed to give relief. The first of these consists in uniting the intestine above and below the obstruction by lateral anastomosis or implantation in order to sidetrack the obstruction; the second, is to create an artificial anus above the obstruction. It must be remembered, however, that an artificial anus established at a point above the lower half of the ileum is generally accompanied by rapid emaciation, asthenia, and death, and the skin surrounding the opening is excoriated and kept in a state of acute inflammation by the irritating intestinal fluids.

Diseases Caused by Congenital or Acquired Diverticula of the Intestine.

Intestinal diverticula, as is well known, are divided into two general classes—the congenital and the acquired. The most frequently observed type of the *congenital* variety is the one known as Meckel's diverticulum. As recently described by Léon Cahier, in his admirable essay upon the subject, a Meckel's diverticulum possesses the following characteristics: "It is single; it has a rectangular implantation into the free border of the terminal portion of the ileum, generally in the neighborhood of the ileocæcal valve; it is made up of all of the coats of the intestine; it is generally more than 2 cm. in length; and it has a terminal filament which may be free or attached to the abdominal wall, the mesentery, or another part of the intestine." The *acquired* diverticula, on the other hand, are, as a rule, multiple, small, thin walled, and round or ovoid in shape. They may be found in any part of the intestinal canal, but are more frequent in the left colon and the rectum, and are, in reality, hernial protrusions of the mucous membrane through the separated fibres of the muscular coat (Fig. 219).

Acute Diverticulitis.—An acute inflammation of Meckel's diverticulum may simulate an acute appendicitis so accurately that a differential diagnosis is not possible. The writer recently operated upon such a case, and on opening the abdomen found the diverticulum, acutely inflamed, lying in the right iliac fossa. In appearance and size it so closely resembled an inflamed appendix

FIG. 219.



Acquired diverticula of sigmoid.

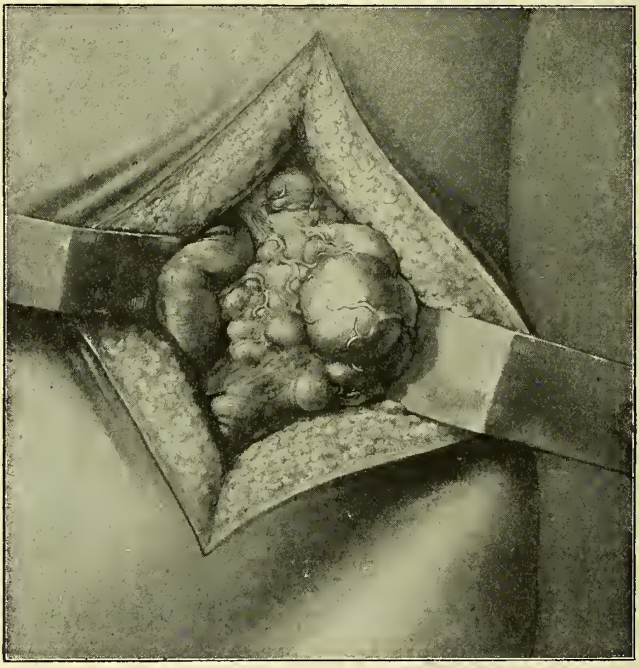
that the true nature of the condition was not recognized until its relation to the ileum was demonstrated.

Treatment.—The treatment in these cases should be removal of the diverticulum when this is possible and closure of the iliac wound by Lembert sutures. When this is not practicable, either from the size of the junction or from the presence of gangrene, intestinal resection is to be recommended.

Acute diverticulitis of the sigmoid or colon has only recently been recognized as a distinct surgical disease. In 1907 the author reported to the American Surgical Association a series of cases of left-sided intra-abdominal infection, in two of which the cause of the symptoms was proved to be the rupture of an acquired diverticulum of the sigmoid.

Symptoms.—The symptoms of acute diverticulitis of the sigmoid are pain, tenderness, and muscular rigidity in the left iliac region. Fever quickly follows these initial symptoms, and leucocytosis is generally present. If rupture occurs, symptoms of spreading peritonitis may quickly develop, or if the process is limited by adhesions the signs of an intra- or extra-abdominal abscess will appear.

FIG. 220.



Acute diverticulitis of sigmoid.

The clinical history of these cases so closely resembles that of acute appendicitis that one instinctively thinks of a transposition of the viscera. Fig. 220 represents the condition found at operation in a case reported by the writer to the surgical section of the American Medical Association in June, 1908.

Treatment.—Regarding the treatment of this condition it may be stated that sufficient data are not available to enable one to determine what percentage of inflamed diverticula actually perforate, and it is, therefore, not possible to state dogmatically whether a given case of acute diverticulitis with comparatively mild symptoms should be subjected to immediate operation or should be treated more conservatively. In the writer's opinion, however, the clinical course of the disease is so similar to the various forms of acute appendicitis that the treatment should be the same. Certainly in all acute cases with severe and progressive symptoms safety lies in early operation. If the diverticulum is small or attached to the bowel by a narrow pedicle, removal with closure of the intestinal wound by a purse-string or several Lembert sutures would be indicated, provided the surrounding intestinal wall was not too much infiltrated. In the event of the diverticulum being large, attached by a broad base, or covered by a plexus of enlarged vessels, the safest method would be to deliver the affected loop of intestine through the abdominal wound and treat it temporarily as an extraperitoneal lesion. If the situation of the lesion is such that extraperitoneal treatment cannot be carried out, packing with gauze from the abdominal wound to the lesion is to be advised, leaving this packing in place from forty-eight to seventy-two hours, or until firm adhesions have formed around the gauze column; then removal of the gauze and free opening of the abscess, allowing it to drain through the channel thus formed.

If rupture has already occurred, the intestinal wound should be united by suture, if this is possible; if not, adequate drainage should be provided.

In the treatment of spreading peritonitis or intra-abdominal abscess from this cause the same principles should be followed as in other abdominal conditions.

Chronic Diverticulitis of the Sigmoid.—William J. Mayo recently called attention to a chronic form of acquired diverticulitis of the sigmoid, which, in its clinical history and gross appearances at operation, strongly resembles carcinoma.

The disease usually occurs at the cancer age, and gives rise to a slowly progressive stenosis with tumor formation.

Excision of the diseased area is indicated in those cases in which mechanical obstruction exists or is imminent.

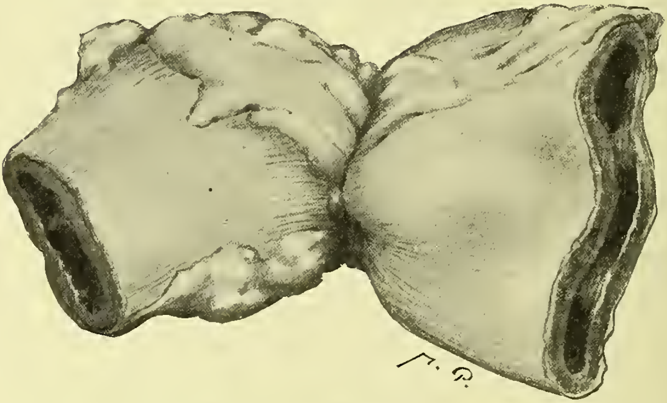
Obstruction or **strangulation** of the bowel not infrequently occurs as a result of a loop of intestine being incarcerated under a Meckel's diverticulum, the distal extremity of which is attached to the mesentery or abdominal wall. The symptoms and treatment of this condition are considered in the section on Intestinal Obstruction.

Tumors of the Intestine.

Tumors of the intestine, as in other regions, are divided into two general classes, the innocent and the malignant. Of the innocent tumors, fibromata, myomata, adenomata, lipomata, and cysts are described by Maylard[1] as occurring in the small intestine; and papillomata, adenomata, fibromata, and lipomata in the large bowel. Carcinomata and sarcomata occur in all parts of the canal, the former being more common in the large, the latter in the small intestine.

As a rule, the *non-malignant tumors* grow slowly and give rise to no disturbance until they attain a sufficient size to produce obstruction. The fibromata, myomata, and adenomata generally form polypoid masses; the lipomata arise from the submucous tissue and may be multiple. All of these conditions are rare. An intestinal polypus not infrequently induces intussusception. In such cases the tumor is often found at the apex of the projecting mass.

Fig. 221.



A carcinoma of the sigmoid, causing total obstruction. (Drawn from a specimen removed by Dr. W. T. Bull.)

Cysts of the intestine or mesentery are rare, but form an interesting group on account of their etiology. Dowd believes most of them to be of embryonic origin. They vary in size greatly, may contain a clear serous fluid or chyle. They rarely give rise to symptoms calling for surgical intervention.

Carcinoma of the intestine is generally of the columnar cell variety. The tumor, as a rule, grows around the gut and forms a constriction similar to that which would be produced by tying a piece of twine about it (Fig. 221). In other cases the growth infiltrates the walls, but in all cases it grows *concentrically* and produces stenosis. If extremely cellular, it is often described as medullary or encephaloid cancer; if fibrous, as scirrhous. It may undergo colloid degeneration and spread rapidly to other abdominal organs.

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[1] The Surgery of the Alimentary Canal.

Sarcoma occurs as a polypoid growth, projecting within the canal; or as a rapidly infiltrating tumor thickening the walls of the canal, growing *eccentrically* and producing dilatation. The first form is usually of the spindle-cell variety; the second, the round-cell or lymphosarcoma. Both varieties arise from the submucous layer. Lymphosarcoma of the small intestine may occur in any part. It grows with great rapidity and extends to the surrounding peritoneum. It may occur at any age, but is rare after forty. Carcinoma, on the other hand, is more common after forty, although Libman states that not infrequently it has been reported in individuals between fifteen and twenty-five, and has been observed as a congenital affection.

Symptoms of Tumor of the Intestine.—Growths of the duodenum are exceedingly rare. When sufficiently developed, they produce symptoms of obstruction. If situated high up, the obstruction resembles that of pyloric stenosis. If lower down, there may be, in addition, obstruction of the common bile-duct and canal of Wirsung. In these cases the patients rapidly emaciate, and jaundice and vomiting are prominent symptoms.

Innocent tumors in the small intestine situated below the duodenum rarely give rise to symptoms unless they act as the exciting cause of an intussusception or other forms of obstruction.

Papillomata of the large intestine may give rise to hemorrhages. Maylard cites two cases in which large numbers of these tumors were found in the colon, in one of which carcinomatous degeneration had occurred at one point and transitional forms at several others. The symptoms were localized pain and the passage of mucus and blood.

In carcinoma of the small intestine the symptoms are those of a progressive chronic obstruction coupled with rapid loss of weight and strength and anæmia. Vomiting is more frequent and occurs earlier than in carcinoma of the large intestine. The tumor can rarely be detected until the symptoms of obstruction are manifest. In carcinoma of the large intestine, which occurs by preference in the sigmoid, the cæcum, or the descending colon; the symptoms are at first those of digestive disturbance; later, there may be localized pain, constipation, and attacks of transitory obstruction, caused generally by impaction of some solid substance in the narrowed lumen of the strictured canal. In many cases no tumor can be felt at any period of the disease; exceptionally it may be detected early. It is usually small and exceedingly hard; it may be movable at first, but soon becomes firmly adherent. The symptoms develop more slowly than in cancer of the small intestine, and the emaciation and asthenia are less marked. When distention occurs, the dilated bowel can often be made out through the abdominal wall presenting well-marked peristaltic movements.

In sarcoma of the small intestine the symptoms may at first be extremely obscure. The growth of the tumor is usually rapid, and in the majority of cases no obstruction exists. In many cases the symptoms are those of an acute intra-abdominal inflammation: localized pain, tenderness, muscular spasm, and the presence of a large indurated mass resembling an inflammatory exudate. Fever may be present, which still further obscures the diagnosis. Libman reports that of 5 cases of sarcoma of the small intestine admitted to the Mount Sinai Hospital, in two years, 3 were sent in with a diagnosis of acute appendicitis. Sarcoma of the large intestine is exceedingly rare. It occurs generally in the cæcum. (Plate X.).

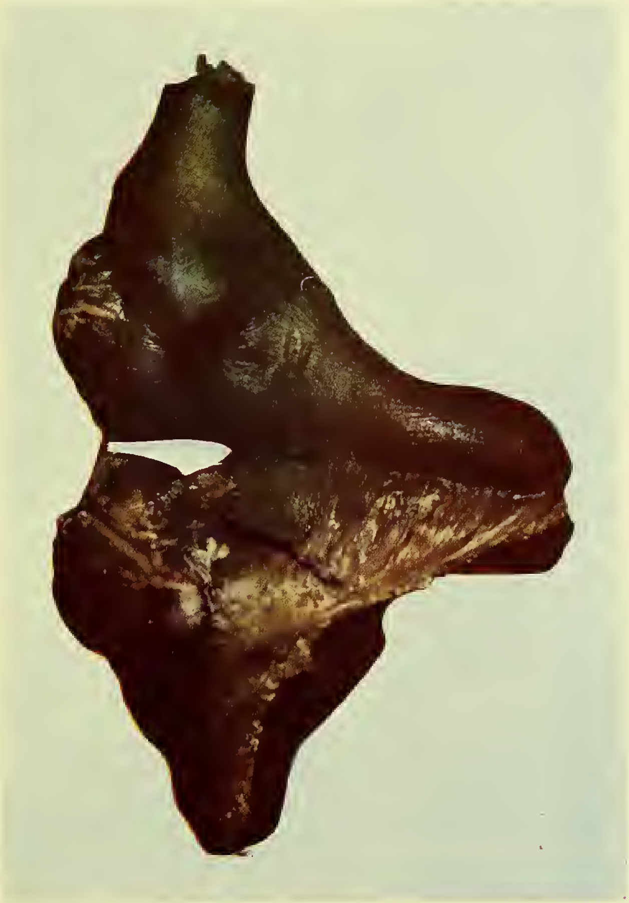
Ulceration of malignant growths of the intestine is of frequent occurrence in the later stages; and perforation may occur, giving rise to a localized or spreading peritonitis, or to an intra- or extraperitoneal abscess.

Tuberculosis or syphilis of the intestine may occasionally give rise to tumors which closely resemble carcinomata or sarcomata. The former condition is described as *hyperplastic intestinal tuberculosis;* in the latter condition the lesions are generally gummatous in character, and may extend into the mesentery. Accurate diagnosis from gross appearance is often impossible.

Treatment.—Innocent tumors of the intestine rarely come under the care of the surgeon unless they produce obstruction or hemorrhage. They are, however, occasionally encountered in operations for intestinal obstruction, and should be removed by enterotomy or resection of a portion of the bowel.

The treatment of malignant disease of the intestine is, as a rule, unsatisfactory, for the reason that the diagnosis is seldom made at a sufficiently early period in the disease to admit of radical removal. If, as often happens in carcinoma of the large intestine, the surgeon is called during an attack of acute obstruction, the indications are to relieve the obstruction by colostomy or ileostomy, and to postpone any radical operation until the patient recovers completely from the acute attack. At the primary operation the surgeon often can locate the growth, examine as to the presence or absence of adhesions and lymph-node metastasis, and thus decide as to the desirability of attempting radical removal at a subsequent period.

PLATE X



Melanosarcoma of Jejunum.

Colored photograph of specimen in author's collection. (Lumiere process.

If the disease can be attacked at an early period, before obstruction and before there is extensive lymph-node involvement, radical removal by enterectomy with union of the divided ends of the bowel is indicated. This in the case of carcinoma has succeeded in a sufficient number of instances to justify its attempt in all suitable cases. In sarcoma the outlook is less favorable. Libman was unable to find a single case in literature that had passed the three-year limit after operation. In inoperable carcinoma producing obstruction, creating an anastomosis between that portion of the bowel above the growth with that below often will relieve the pain, distention, and vomiting, and prolong life for a very considerable period of time. If the disease is located low down in the sigmoid, a permanent inguinal colostomy is indicated.

OPERATIONS ON THE STOMACH AND INTESTINES.

All operations on the stomach and upper bowel should be preceded by careful frequent disinfection of the oral cavity, stomach lavage, and the ingestion of only sterilized food and water for thirty-six hours before the proposed operation.

Gastrotomy.

Gastrotomy consists in opening the stomach for purposes of diagnosis, the removal of a foreign body or small pedunculated tumor, or to effect dilatation of the pyloric orifice. A median incision should be made about four inches in length, beginning at a point about one inch below the ensiform cartilage. When the peritoneal cavity is opened, the stomach is drawn into the wound and the adjacent viscera protected by the insertion of several pads of gauze, to each of which an artery-clamp or metal ring has been attached. An incision is then made in the anterior wall of the stomach parallel with its longitudinal axis, and through this whatever further manipulations are necessary are carried out. The stomach wound is then closed by two rows of sutures, a deep one of catgut including all the coats but the mucous, and a superficial row of silk sutures introduced by the Lembert or Halsted method. The abdominal wound can then be closed by layer suture, catgut for the peritoneum, chromicized catgut for the muscular and aponeurotic layers, and silk-worm gut for the skin, or by through-and-through silk-worm gut or silver wire sutures. The latter method in the upper part of the abdomen is thought by many surgeons to give results equally as good as the layer suture.

Digital or Instrumental Dilatation of the Pylorus.

Digital or instrumental dilatation of the pylorus may be carried out through a gastrotomy wound by the fingers or by the use of a uterine dilator. The method is dangerous and seldom used.

Pyloroplasty.

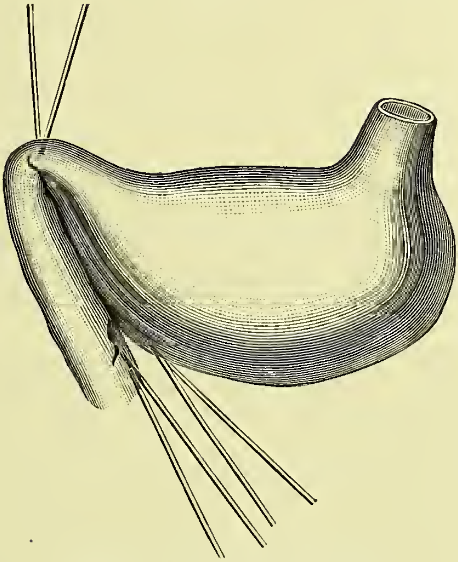
Withdraw the pylorus through a median incision in the abdominal wall. Make a longitudinal incision through the stricture. Convert the longitudinal incision into a transverse opening by drawing the edges of the wound widely apart by two blunt retractors, and unite by a double row of Lembert or Halsted sutures.

Finney, of Baltimore, has devised a new and satisfactory method of pyloroplasty. He first frees the region of the pylorus from all adhesions, then introduces a silk retractor at the summit of the pylorus, another through the anterior wall of the stomach about three inches from the first, and a third through the anterior wall of the duodenum the same distance from the pylorus. By drawing the first retractor upward, and the two others downward, the anterior surfaces of the stomach and duodenum are brought into contact and united by a row of peritoneal sutures of silk. An inverted U-shaped incision is then made through the walls of the stomach, pylorus, and duodenum about half an inch from the line of suture. The adjacent mucous and muscular coats of the stomach and duodenum are then united by a continuous suture of catgut, and the opening closed by a row of mattress sutures, as seen in Figs. 222 and 223. This operation insures permanent patency and good drainage from the dependent position of the stomach outlet.

Pylorectomy, or Partial Gastrectomy.

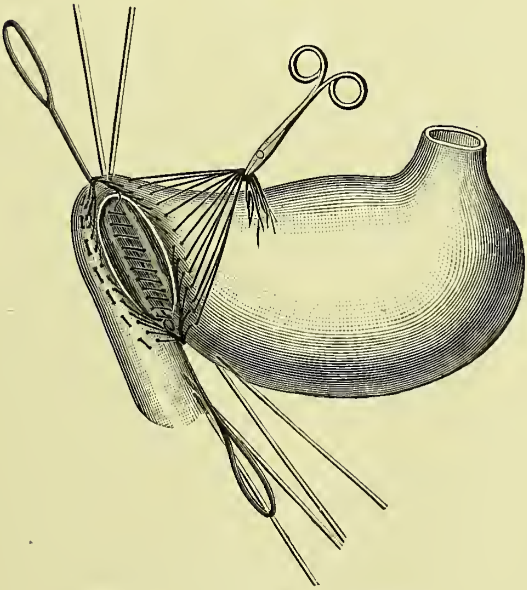
This operation is indicated in cases of early carcinoma of the pylorus. As Cuneo has demonstrated that the lymphatics which drain the pyloric end of the stomach follow the gastric vessels along the lesser curvature to a point where the gastric artery leaves the viscus and passes downward to the cœliac axis, and that the lymph-vessels of the greater curvature pass toward the pylorus from a point about five inches to the left of the duodenal junction, it is evident that to remove these and their associated nodes the line of incision through the body of the stomach must be an oblique one from the junction of the gastric artery to the lesser curvature, downward to a point about five inches from the pylorus on the greater curvature. It will thus be seen that the older methods of pylorectomy advised by Billroth and Kocher

Fig. 222.



Finney's operation: position of parts.

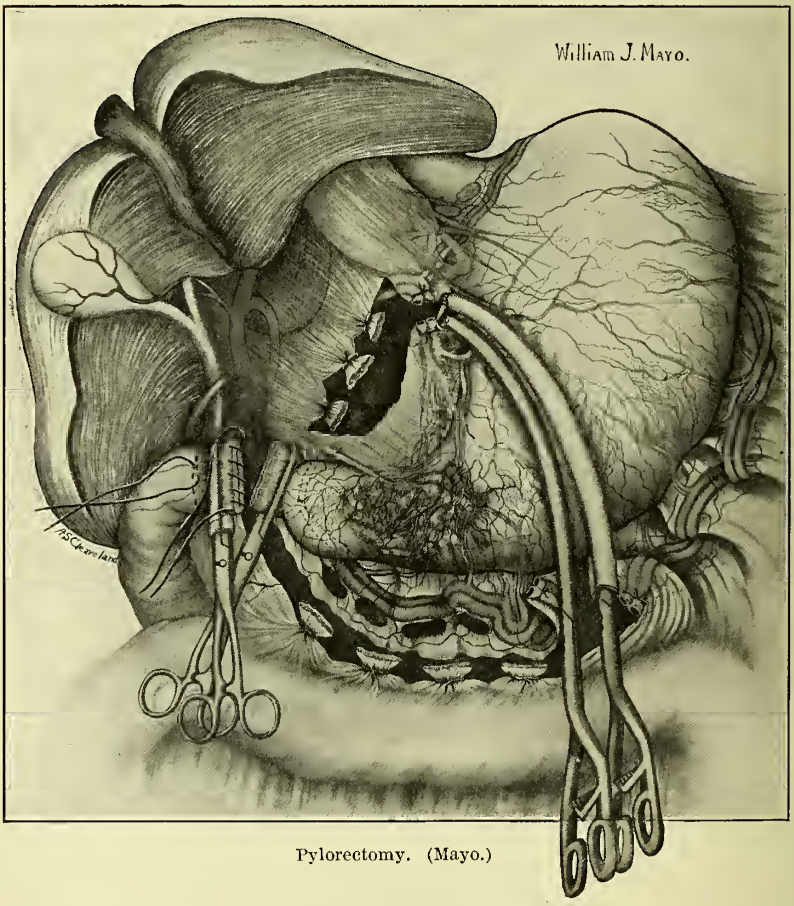
Fig. 223.



Finney's operation: sutures in place.

were inadequate, in that they removed too little of the stomach-wall. The technic of the Mayo operation based upon these observations is as follows: A generous median incision is made over the gastric area and the pyloric end of the stomach withdrawn. Four ligatures are next placed on the main arteries—one on the gastric as it joins the lesser curvature, one on the pyloric, and two

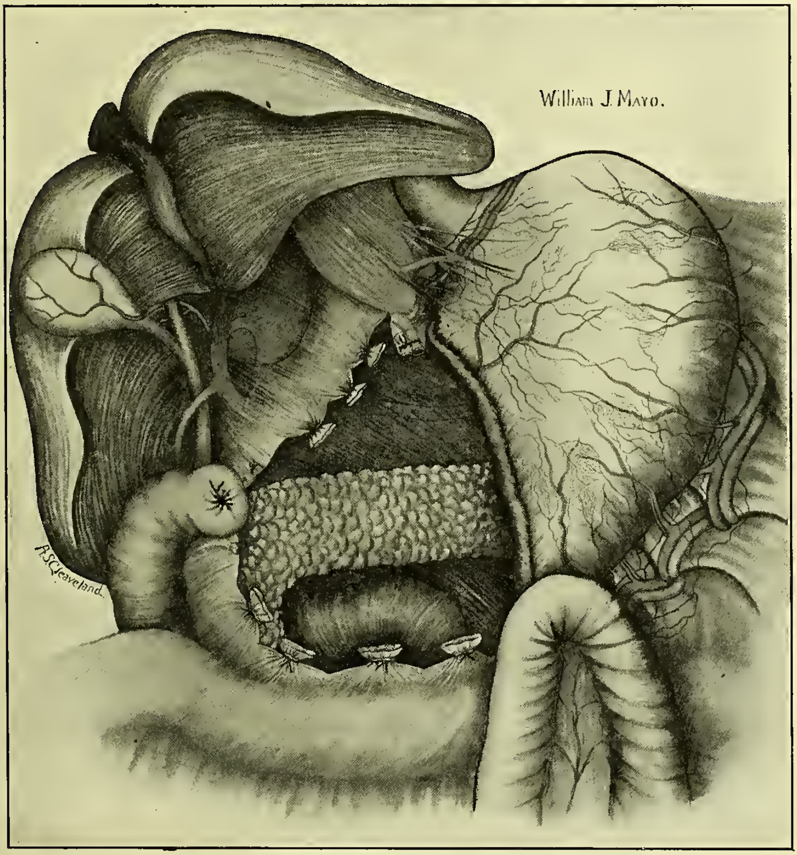
Fig. 224.



Pylorectomy. (Mayo.)

on the gastric epiploica dextra at the points of excision. The greater and lesser omenta are then ligated and divided some distance from the stomach, so as to leave the lymph-nodes and vessels attached to the portion to be removed. The peritoneum is then protected by gauze pads, the duodenum clamped by two long-bladed forceps, divided, and the cut edges disinfected. The duodenal orifice is next closed by a purse-string suture of chromic catgut. Two other clamps are then placed across the body of the stomach in the line indicated above and the tissues divided between them. After disinfecting the wound edges, the gastric opening is closed with two layers of sutures and a gastro-enterostomy performed (Figs. 224 and 225).

FIG. 225.



Pylorectomy. (Mayo.)

Gastrectomy.

This operation, which consists in removal of the greater part of the stomach, may rarely be indicated for carcinoma involving the body of the organ. The method is exactly the same as in pylorectomy, except that a larger area is removed. It will rarely be possible to unite the duodenum with the cardiac remnant of the organ, and resort must be had to a union of the jejunum with the œsophageal extremity.

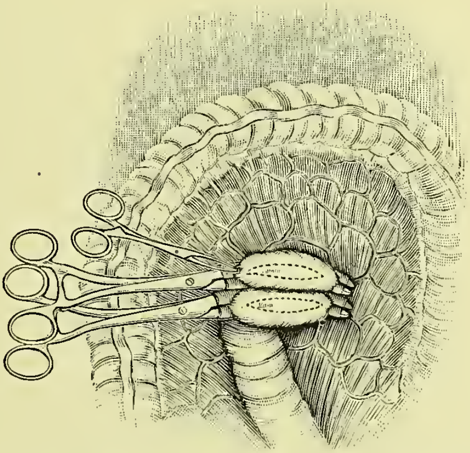
Gastrostomy.

The following method, which is a slight modification of Kader's procedure, is the simplest and safest method of gastrostomy, and has the advantage of a valve action which prevents leakage and insures rapid spontaneous closure of the wound when the necessity for the fistula has passed: Through a vertical abdominal incision just to the left of the median line the anterior wall of the stomach is drawn into the wound and held by clamps or a provisional suture. Two circular sutures of catgut are then passed through the peritoneal coat, the first making a circle half an inch in diameter, the second surrounding the first, about half an inch from it. The ends of each suture are left long. A small incision is then made with a scalpel in the centre of the small circle, and through this is passed a No. 26 F. soft-rubber catheter. As this is being introduced, the first suture is tied so as to invert the peritoneum along with the catheter. The second suture is tied while the catheter is again pressed inward, still further inverting the wall of the stomach. The abdominal wound is then closed with through-and-through silk-worm gut sutures; the ones placed just above and below the emerging catheter also include the peritoneal coat of the stomach. The tube should be left in place five or six days, after which it may be removed and introduced only when a feeding is necessary. If the conical inversion of the stomach-wall is sufficient, no leakage will take place.

Gastro-enterostomy.

This operation is indicated in malignant or benign pyloric stenosis, and in certain cases of gastric ulcer. Several methods are in use. The one most frequently employed at present is called the *no-loop suture method*. The abdomen is opened in the median line over the gastric area. The transverse colon is withdrawn and held upward. An opening is made in the transverse mesocolon through which the posterior wall of the stomach is drawn. The jejunum is next picked up at the duodenojejunal junction and drawn outward. Two clamps are then placed on the stomach and jejunum, as seen in Fig. 226. Mayo grasps the stomach-wall in such a way that the line of anastomosis will be from above downward and to the left, when the stomach is replaced. Moynihan prefers a perpendicular line, others one inclining slightly toward the right. When the clamps are in place, and the clamped folds of the stomach and intestine placed side by side, a continuous Cushing suture of silk or Pagenstecher linen thread is introduced for about three inches on one side of the proposed opening, uniting the peritoneal coats of the adjacent viscera. A longitudinal opening is next made into the stomach and intestine and the redundant mucous membrane removed. A second line of suture is next placed, uniting the adjacent cut edges of the stomach and gut and carrying it completely around the opening, after which the outside peritoneal Cushing suture is completed. The structures are then replaced within the abdomen and the opening in the transverse mesocolon united about the line of anastomosis.

Fig. 226.



Stomach and jejunum in the grasp of the large clamps, made ready for suturing. Small forceps still marking low point of stomach. (Mayo.)

Some surgeons prefer to employ the Murphy button for the anastomosis. When this is employed, the gastric opening should be near the greater curvature in the most dependent part of the posterior wall.

McGraw, of Detroit, employs an exceedingly simple method of gastro-enterostomy, which consists in attaching a loop of the jejunum to the wall of the stomach by two or three interrupted sutures, then passing an elastic ligature, made of pure rubber, through the stomach and intestinal walls by means of a large curved needle, and, after drawing it tightly, securing it by a knot of silk. The gastric and intestinal surfaces are drawn together and held by a few interrupted sutures to insure adhesion around the elastic ligature, which gradually cuts its way out and is passed by the bowel. Maury has modified the McGraw operation by substituting a triangular stitch of heavy silk for the elastic ligature.

Enterotomy.

Enterotomy is an incision into the large or small intestine for purposes of diagnosis or for the removal of tumors or foreign bodies. The abdomen is opened and the bowel drawn into the wound, the peritoneal cavity being protected by gauze pads. The incision into the bowel should be made in a longitudinal direction, and closed with the Lembert or Halsted suture.

Enterectomy.

Enterectomy, or removal of a section of the intestine, is indicated for the extirpation of a new growth or stricture, the cure of an obstinate fecal fistula, or in the treatment of extensive wounds or gangrene of the gut. If the portion to be removed is movable and has a mesentery, it is drawn outward through an abdominal incision, the peritoneum carefully protected with gauze pads, and the lumen of the bowel above and below the diseased or injured area closed by clamps or gauze ligature. A V-shaped incision is then made, including the intestine and a portion of the mesentery, the vessels ligated, and the mucous edges disinfected with hydrogen peroxide or bichloride solution. The two ends may then be united by circular enterorrhaphy or by the Murphy button.

If the portion to be removed is fixed and has no mesentery, as the cæcum, the ascending or descending portions of the colon, it is often wiser to make the operation in two stages. At the first operation the intestine above the diseased portion is united by lateral anastomosis to the part below the area to be removed; as, for instance, uniting the ileum with the transverse colon in disease of the cæcum, or the transverse with the descending or sigmoid colon in a lesion of the splenic flexure. At the second operation the diseased area is removed and the two divided ends closed by a purse-string suture and reinforced by additional Lembert sutures or an omental graft.

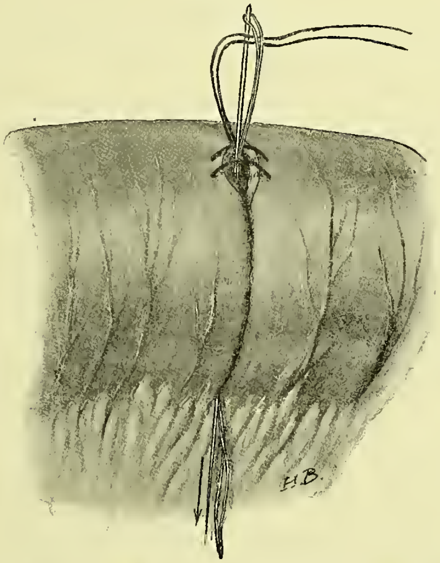
It is obvious that in cases of acute trauma or gangrene both procedures must be carried out at the same time.

Circular Enterorrhaphy.

This may be accomplished by means of the Cushing or Connell suture. If the former method is employed, the two ends of the divided intestine are approximated by fixation sutures or small forceps, and a continuous Cushing suture carried around the circumference. Each stitch includes the serosa muscularis and submucosa, and is introduced about one-quarter of an inch from the free border. Great care should be taken to insure complete closure of that portion of the bowel between the two layers of the mesentery; and, as there is no peritoneum to unite at this point, a small portion of the mesentery may be inverted to insure early adhesion.

If the Connell suture is employed, the two open ends of the gut to be united are placed side by side, with the mesenteric border of each in contact. Lateral traction sutures are next placed to insure a uniform approximation. A continuous suture is next introduced, including all the tunics of the bowel, and by changing the position of the traction sutures about three-quarters of the circumference of the gut can be rapidly united from within. In introducing the last few stitches the edges must be separated, but the same form of suture continued until the entire circumference is united. The two extremities of the suture are then drawn into the lumen of the bowel and again outward at another point in the circumference by means of a blunt-pointed Reverdin or ordinary threaded needle introduced backward (Fig. 227). By gentle traction on the suture the two mucous surfaces are approximated and the knot tied. As soon as the remaining ends are cut away the knot sinks inward and leaves a smooth line of peritoneal approximation throughout the entire circumference.

Fig. 227.

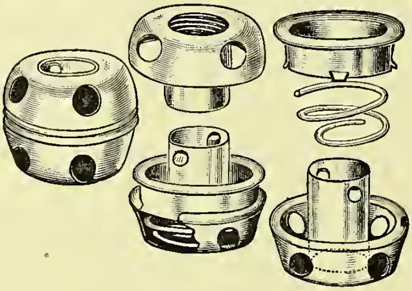


Connell's suture: Method of inserting needle for tying the last knot. (Kelly-Noble.)

Anastomosis by the Murphy Button.

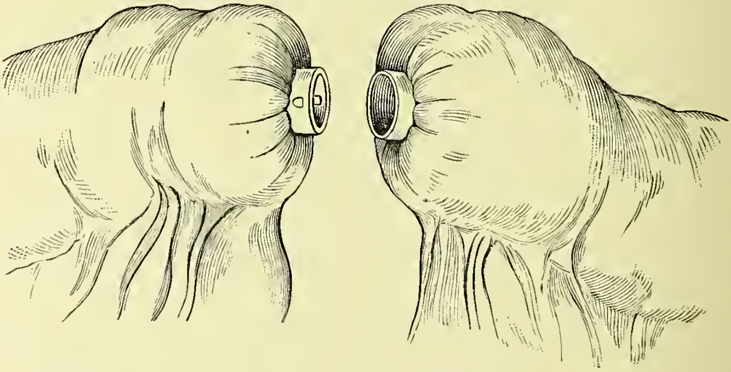
This is the quickest and often the safest method of intestinal anastomosis. The Murphy button (Fig. 228) consists of two perforated metal disks, each having a hollow metal stem of such a size that one telescopes into the other, and is securely held in place by a spring catch acting on a thread on the interior of the female stem. By this contrivance the divided ends of the intestine can be securely held in place by approximating their inverted peritoneal coats. Union takes place externally, and the inverted edges eventually slough, allowing the closed button to become free and to pass outward along the intestine. The method of anastomosis by the button is as follows: A continuous suture of silk or catgut is carried around the free edge of the gut, making a double turn at the attachment of the mesentery. One half of the button

Fig. 228.



Murphy button.

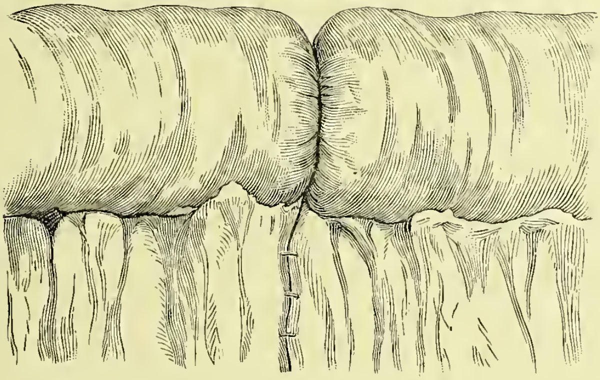
Fig. 229.



The two portions of the Murphy button held in position by purse-string sutures. (Richardson.)

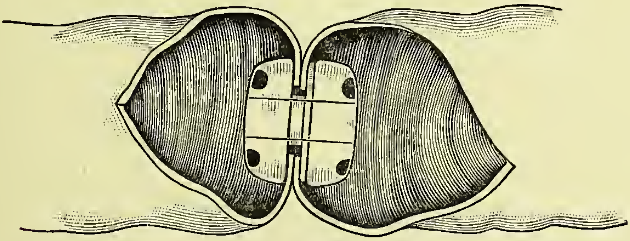
is introduced and the suture tied (Fig. 229); the other half is placed in the other end of the divided intestine and secured in the same manner; the two are then united and the buttom firmly joined by pressure (Figs. 230 and 231). After careful disinfection the united intestine is dropped into the peritoneal cavity and the wound closed without drainage.

Fig. 230.



End-to-end approximation; button in position. (Richardson.)

Fig. 231.

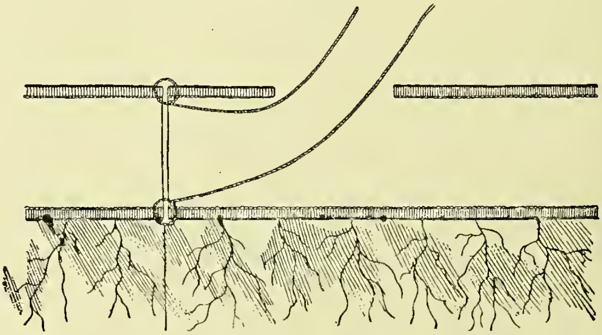


End-to-end union of intestine with a Murphy button. (Richardson.)

Maunsel's Method of Enterorrhaphy.

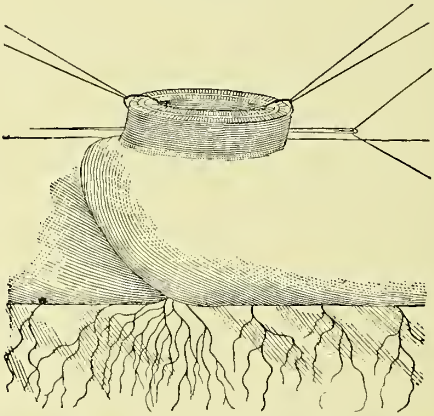
In this operation the divided ends of the intestine are united by two silk sutures, one at the mesenteric border and one at the free opposite border. An incision is then made longitudinally into the bowel an inch or more from the divided ends on the distal side of the anastomosis, and through this incision the two silk sutures are carried (Fig. 232). Drawing these sutures outward through the longitudinal wound invaginates the two approximated portions, which are eventually drawn outward through the distal opening (Fig. 233). The approximated edges are then united by a continuous silk suture penetrating all three coats. When this is completed, the invaginated gut is reduced and the longitudinal wound united by Lembert sutures. After union of the mesentery and disinfection of the parts the intestine is returned to the abdominal cavity and the parietal wound closed.

Fig. 232.



Maunsel's method: first two sutures brought out through the incision in the lower segment.

Fig. 233.



Maunsel's method; protruding ends ready for suture.

Lateral Anastomosis.

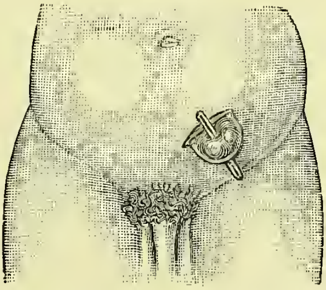
Lateral anastomosis is often necessary to sidetrack a stricture of the intestine or to unite the bowel after enterectomy when one portion is immovable or only partly surrounded by peritoneum, as in the case of the ascending or descending colon. It can generally be accomplished by the use of the Murphy button introduced as in gastro-enterostomy.

Abbe's method consists in closing both ends of the divided intestine by Lembert sutures, placing the two portions of the bowel side by side and uniting them for a distance of two or three inches by a continuous peritoneal suture of silk, leaving the suture long at each extremity of the line. Next incise both portions of the intestine one-quarter of an inch from the suture-line, introduce a second line of catgut sutures uniting the adjacent cut edges of the gut, and carry it entirely around the opening; then introduce an outer row of peritoneal sutures on the side opposite to the first row, tying each extremity to the long end left of the first peritoneal suture.

Colostomy.

This operation is indicated in carcinoma of the sigmoid or rectum, and in other cases in which temporary or permanent absence of fecal discharges through the rectum is desirable. Maydl's method consists in making an incision in the left inguinal region parallel with the fibres of the external oblique aponeurosis, and carrying the incision through all layers until the peritoneal cavity is opened. The upper part of the sigmoid flexure is found and drawn outward through the wound. A glass rod is passed through its mesentery and allowed to project on either side on the abdominal wall, to prevent return of the loop or gut. The peritoneum may be stitched to the protruding intestine and the wound partly closed (Fig. 234). When possible, the opening into the bowel should be delayed for twenty-four or forty-eight hours, until

Fig. 234.



Inguinal colostomy. (Tillmanns.)

the peritoneal cavity is thoroughly sealed by adhesions. Colostomy may occasionally be necessary at a higher point in the colon. In the transverse portion there is little difficulty in removing a knuckle of the bowel; but in the cæcum, ascending or descending colon, this may be impossible if there is no mesentery. In these cases the presenting portion of the colon may be united to the parietal peritoneum, and the edges of the opening kept apart by gauze packing until adhesions have formed, after which the bowel may be incised. Weir's method of establishing a permanent artificial anus is to divide completely the sigmoid, close the distal portion and drop it back into the pelvic cavity, then carry the proximal portion beneath the skin to an opening just over the crest of the ilium, to which its edges are united. This insures freedom from fecal invasion of the lower segment and an artificial anus which can in a measure be controlled.

APPENDICITIS.

The vermiform appendix is an anatomic relic due to gradual reduction in size of the cæcum. In man and the anthropoid apes it is found as a diminutive blind intestinal tube opening into the caput coli. It possesses the same anatomic structure as the intestine. Its mucous membrane is richly supplied with lymphoid tissue. So abundant is this tissue that sometimes the appendix is spoken of as the abdominal tonsil. Its cæcal orifice is guarded by a fold of mucous membrane, the valve of Gerlach. Under ordinary conditions the abundant secretion of the mucous membrane of the appendix finds its way easily into the intestine, and the valve of Gerlach serves to prevent the entrance of any considerable amount of intestinal matter. If the mucous membrane of the cæcum becomes swollen as a result of some digestive disturbance or inflammatory process, the orifice may become temporarily occluded, causing retention of the secretions of the appendix. The muscular efforts of the appendix to rid itself of this excess of mucus may cause pain, and constitutes the condition known as *appendicular colic.* Other conditions may give rise to this same condition, as the presence within the lumen of the appendix of a small amount of fecal matter, the fluid portion of which has been absorbed, leaving a small oval mass which resembles in appearance a grape- or date-seed (a circumstance which accounts for the popular impression that the presence of such seeds is the cause of appendicitis[1]). Expulsive muscular efforts on the part of the appendix to rid itself of this foreign body give rise also to appendicular colic. If for any reason this occlusion of the lumen of the appendix is not relieved, the organ becomes distended with mucus; pressure on the mucous membrane causes anæmia and diminished resistance; the pathologic micro-organisms always present (Bacillus coli and others) attack the anæmic membrane and give rise to an inflammatory process which constitutes the *acute catarrhal* form of *appendicitis.* If the obstruction is speedily relieved, this may disappear without damage to the membrane. Generally, however, there has been some necrosis and loss of tissue, which by later cicatrization and contraction gives rise to stricture of the appendix, a condition which favors subsequent recurrence of the trouble, and constitutes one of the forms of *relapsing* or *recurrent appendicitis.* If in an acute catarrhal appendicitis the distention is not promptly relieved, extensive infiltration of the mucous membrane and of the submucous and muscular coats may occur from extension of the inflammatory process, constituting an *acute interstitial appendicitis,* in which the organ appears erect, hot, swollen, and intensely red. If the process extends, and especially if there is added thrombosis of the appendicular vessels or the pressure of a concretion cutting off or seriously compromising the blood-supply, necrosis occurs, which may be limited in extent, giving rise to a perforation, *acute perforative appendicitis,* or a large part or the whole of the organ may slough, *gangrenous appendicitis.*

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[1] Some years ago McBurney stated that he had seen only one grape-seed in the appendix, and that was discovered by accident during a laparotomy for another condition. The appendix in this instance was healthy.

In the simple catarrhal variety there is, as a rule, no involvement of the neighboring peritoneum; if, however, the process extends to the other coats of the appendix, and especially if the infecting agent is a virulent one, peritonitis may develop, even without perforation, from a transudation of septic material through the infiltrated walls of the organ. When perforation occurs, peritonitis always results unless the appendix is located behind the peritoneal membrane, as it occasionally is in the retrocolic variety. As in other peritoneal infections, the resulting peritonitis may be localized or diffuse. If localized, it may be plastic and result in a matting together of the neighboring viscera. This form is fairly common, and occurs often in cases before perforation has occurred. In the majority of cases, however, in which perforation occurs, an intraperitoneal abscess forms, the walls of which are formed by a mass of the intestine and omentum matted together with plastic exudate, separating the septic focus completely from the general peritoneal cavity. This constitutes an *appendicular abscess.* If the inflammatory process in the peritoneum which results from a rupture of an inflamed appendix is not quickly walled off by adhesions, or if the amount of septic fluid which escapes is large and covers an extensive area, or if the virulence of the infecting micro-organisms is great, a diffuse spreading or general peritonitis results. In abnormally placed appendices, outside the general peritoneal sac, abscesses may be produced which never communicate with that cavity. Thus in retrocæcal or retrocolic appendices the abscess lies behind the peritoneum in the flank, often as high as the kidney. Appendicular abscesses have also been reported on the left side of the abdomen or pelvis, and in the sac of a femoral hernia.

Appendicular abscesses may develop slowly or rapidly, depending largely on the virulence of the infection and the resistance of the individual. They may rupture into one of the hollow viscera, externally, or into the free peritoneal cavity, and thus occasion an acute spreading peritonitis.

Symptoms.—In the simple cases of appendicular colic the only symptom may be acute abdominal pain, which occurs suddenly after some indiscretion in diet, or it may occur without any apparent exciting cause. The pain is at first more or less general, or it may be felt with greatest intensity in the region of the umbilicus. At a later period it generally becomes localized in the right iliac fossa. Vomiting may occur, but there is no fever or constitutional disturbance. Such cases are generally described as acute indigestion, intestinal colic, etc., and are often promptly relieved by vomiting or by a small dose of morphine administered hypodermically. In the acute catarrhal variety the symptoms may resemble at first those of an appendicular colic; generally, however, the pain is less acute and is accompanied by nausea and vomiting. There is a slight elevation of temperature, and the pulse may become more rapid. The patient complains of a constant ache over the appendix, as well as paroxysms of acute pain. Tenderness is present over McBurney's point;[1] there is little or no muscular rigidity. The temperature may rise a degree or two, and the pulse is frequently accelerated. Exceptionally the fever may reach 102° or 103° F. for a short period, but in these cases the fever is probably due to an associated intestinal toxæmia. A blood-count may show a slight increase in the leucocytes, rarely above 12,000. The condition may remain stationary for a few hours and then gradually subside, or the inflammation may extend to the other coats of the appendix. In these cases there are, as a rule, more pain, more fever, and a decidedly increased appearance of illness. The pulse may become more rapid, there is slight spasm of the lower half of the right rectus muscle, and the tenderness is more marked. The blood-count may show a leucocytosis of from 10,000 to 14,000. If the closed appendix contains pus, *empyema of the appendix*, the leucocytosis may be higher. If the process continues until rupture occurs, which may be at any time after twelve hours, there may be a sudden cessation of pain, a temporary remission in temperature, but an increase in the muscular rigidity and pulse-rate. Occasionally rupture and infection of the peritoneum are signalized by a sharp rise in temperature and an increase in the pain and vomiting. If the process remains localized and an abscess forms, the tenderness is increased, the rigidity more marked, and a mass can generally be made out in the region of the appendix. The leucocytes may rise to 16,000 or 18,000, or even more. Chills and sweats may occur and other evidences of sepsis are present. Exceptionally, after the formation of an abscess the temperature falls, the pulse-rate diminishes, the pain is relieved, and the patient feels decidedly better and asks to be allowed to sit up. In the majority of cases, however, patients are prostrated and do not rally until the condition is relieved surgically or the abscess ruptures. Occasionally pyæmia may follow an unrelieved appendicular abscess.

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[1] A point $2\frac{1}{2}$ inches from the right anterior superior spinous process of the ilium on a line to the umbilicus.

If the peritoneal inflammation is not limited to the region of the appendix, but assumes the type of a diffuse spreading peritonitis, there is generalized abdominal pain with universal muscular rigidity and distention. Vomiting occurs and the patient becomes greatly prostrated. The bowels cannot be made to move on account of the paralysis of the intestines, gas accumulates, and pressure on the diaphragm interferes with respiration. The pulse becomes rapid, feeble, and often intermittent; the temperature may fall to the normal or become subnormal. The face becomes pinched, the eyes sunken, the entire body bathed in cold perspiration, and death occurs from peritoneal sepsis. In other cases the temperature becomes greatly elevated, the patient delirious, and death may take place from exhaustion.

Absence of pain in appendicitis is very exceptional. Occasionally cases are encountered in which the disease goes on to the formation of an abscess or a spreading peritonitis without acute pain. Absence of marked fever is more frequent. The writer has on several occasions found a gangrenous appendix and a diffuse spreading peritonitis in patients in whom the pulse and temperature were both below 100.

The **diagnosis** of appendicitis in its early stages is usually easy. In the presence of symptoms of beginning inflammation in the right iliac fossa in women, one must exclude salpingitis, in which the point of maximum tenderness is below McBurney's point, and is generally more easily reached by vaginal examination. In this affection there is usually a history of previous infection either of a puerperal nature or the result of abortion or an invasion by the gonococcus. The uterus is more or less fixed and the roof of the pelvis is rigid. Typhoid perforation can be excluded by the history. An ulcerating carcinoma of the intestine, by the absence of symptoms of obstruction, and the loss of weight and strength which usually accompanies this disease before ulceration and perforation take place. Renal colic may simulate very closely appendicular colic, and a diagnosis between the two is not always possible. Tenderness over the kidney, pain radiating to the groin and testicle, absence of fever and muscular rigidity, and presence of blood in the urine, would point to a renal origin of the pain. Pain in the right inguinal region and tenderness over McBurney's point are frequently present in women just before or during menstruation, but without fever or muscular rigidity. In hysteric subjects the pain may be severe, and require morphine or chloroform for its relief. Appendicular abscess may be simulated by a strangulated ovarian cyst, by a rapidly growing intestinal sarcoma, by a retroperitoneal abscess of renal origin, or from lymphatic infection from the lower extremity, genitals, or pelvic organs, by tuberculosis or actinomycosis of the appendix or cæcum, and by an acute inflammation of a congenital or acquired intestinal diverticulum. These can only be excluded by a carefully taken history, and in the case of tuberculosis by the blood-count. Psoas or iliac abscess may rarely simulate this condition. These can generally be excluded by the history of disease of the spine or pelvic bones, and by the chronicity of the affection.

In palpating the contents of the iliac fossa Meltzer has recently called attention to the advantages to be gained by a contraction of the iliopsoas muscle. By instructing the patient to raise the entire limb from the bed the muscle is brought nearer to the anterior abdominal wall, and any structure lying upon it can be more easily palpated.

In the presence of symptoms of general peritonitis without localized signs, one must consider, in addition to the appendicular and tubal origins of such inflammations, a perforated gallbladder, perforation of an ulcer of the stomach or duodenum, acute pancreatitis, diverticulitis, and intestinal obstruction. In the first four conditions the pain, tenderness, and rigidity begin in the upper part of the abdomen, whereas in appendicitis they begin below. In gall-bladder disease and in perforations of the stomach or duodenum there is usually a history of previous disease or disturbed function in these organs. In intestinal obstruction obstipation exists before symptoms of peritonitis, which generally results from a perforation of the bowel above the seat of obstruction. In many of these cases an accurate diagnosis is impossible except by exploratory operation.

Treatment.—Without entering into a discussion of the various methods which have been employed in the treatment of this condition in the past, it may be stated that at the present time the consensus of opinion among surgeons is that appendicular colic without fever, muscular rigidity, or leucocytosis can be safely treated by rest, an ice-bag, fasting, and an opiate if necessary, until the attack has subsided ; to be followed in the interval by removal of the organ. Catarrhal appendicitis which has passed the acuteness of the attack with a declining temperature, pulse-rate, and leucocytosis, and with diminishing pain and tenderness, may also be treated in the same manner. All other cases should be operated upon as soon as the diagnosis is made, if the condition of the patient warrants the administration of an anæsthetic and the surroundings are such as to admit of an aseptic operation with competent assistants.[1] In interval cases the mortality following the operation should be less than 1 per cent. ; in early acute cases when the inflammation is limited to the appendix the mortality should not exceed 2 or 3 per cent. ; in abscess cases, not greater than 5 per cent. ; but in late neglected cases when there is a diffuse peritonitis the mortality will be from 50 to 80 per cent., the former figure representing the mortality to be expected in children, the latter in adults.

In cases in which the conditions are such as to preclude the possibility of an operation the treatment should be rest, ice, opium, and starvation, preceded, if possible, by evacuation of the stomach and bowels. These measures will serve to diminish peristalsis and favor subsidence of inflammation, or at least do away with the factors which tend to favor its rapid spread. Under no circumstances should cathartics be given to patients in whom there is a possibility of an acute appendicitis. The author believes cathartic medication to be responsible for early perforation in a large number of cases.

Intermuscular Appendectomy (*McBurney's Operation*).—This is the simplest and safest operation on the appendix. It is indicated in all cases during the interval between the attacks when there is no reason to expect serious adhesions or other complications which render a large opening necessary. It is also indicated in acute cases when the inflammation is limited to the appendix, and when the abdominal cavity can be tightly closed after removal of the disease. An incision two or three inches in length is made parallel with the fibres of the external oblique aponeurosis, the centre of which will lie a little to the outer side of McBurney's point. This divides the skin and subcutaneous tissues down to the aponeurosis. The aponeurosis is then split in the direction of its fibres and well retracted, exposing the internal oblique, the fibres of which are next separated by blunt dissection and retracted in the opposite direction. The transversalis fibres can then be separated in the same manner, which exposes the thin transversalis fascia and subperitoneal fat. These structures are carefully divided and the peritoneum drawn upward in a transverse fold by two mouse-toothed forceps, and opened by the scissors or scalpel. The colon will generally be found immediately beneath this opening, and if one of its longitudinal bands is followed downward while the bowel is being drawn upward into the wound, it will be found to lead directly to the base of the appendix. In certain rare instances the colon will not be found in the iliac region. In these cases it will either be found in the right lumbar or hypochondriac region, due to an early attachment of the appendix and a failure of descent; or in the central zone of the abdomen, due to an incomplete rotation of the gut at an earlier period of development. If no adhesions exist, the appendix and cæcum can be drawn outward through the wound, and the peritoneum protected by one or two small pads of gauze. The mesentery of the appendix is next ligated by passing a stout catgut ligature through its folds near the junction of the appendix with the cæcum, and tying it well below the attachment of the mesentery to the appendix. If the mesentery is large, it should be ligated in sections. The appendix is next cut from its mesentery and held upward by an assistant while the surgeon surrounds its base by a silk or fine chromicized catgut purse-string suture. When this is in place, the ends should be knotted, but not tied, and held by an assistant while the surgeon divides the appendix about one-quarter of an inch from the cæcum. A probe is then introduced to insure the patency of the canal, after which the opening is dilated by means of a small pair of thin-bladed forceps, and the stump inverted into the cæcum by another pair of fine forceps grasping the cut margins and pushing them inward. During this manœuvre the assistant tightens the purse-string suture and the small forceps is withdrawn. By this method, which is known as the Dawbarn method, the stump is completely inverted and buried, leaving only a small puckered depression at the surface of the cæcum. The method is the ideal one, and should be employed whenever possible. If, however, there is much infiltration of the cæcum or appendix which prevents its inversion without too much bruising, or if there exist dense adhesions which prevent the drawing upward of the cæcum into the wound, the appendix should simply be ligated near its base with chromicized catgut, divided with scissors, and the exposed mucous membrane treated by a drop of pure carbolic acid or the actual cautery. Before returning the bowel to the abdomen it should be touched with hydrogen peroxide and douched with salt solution. If there is reason to suppose that the peritoneal cavity has been contaminated, the wound should be well retracted and the surrounding intestines carefully wiped by moist gauze sponges or douched with sterile salt solution.

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[1] Ochsner follows a somewhat different plan of treatment, based upon the fact that in his cases the greatest mortality occurred in patients operated upon during the third, fourth, or fifth day of the disease. He advocates immediate operation in all cases seen during the first thirty-six hours. If seen later, he advise streatment by rest, stomach lavage, rectal feedings, ice to the inguinal region, and sufficient opium to overcome peristalsis, with a view to limiting the spread of the inflammation; operation to be performed after the fifth day. The author's experience with this method has not been satisfactory.

The peritoneum is closed with a continuous catgut suture, the muscles allowed to fall together and held by one or two catgut interrupted stitches, the aponeurosis united in the same manner as the peritoneum, and the skin wound closed by two or three silkworm gut or silk sutures. A small subcutaneous rubber tissue drain may be left in for twenty-four or forty-eight hours. If primary healing occurs, the patient may leave the bed on the eighth or ninth day.

The Operation for Acute Appendicitis.—In the presence of a tumor indicating an inflammatory exudate or an appendicular abscess the incision should be made over the most prominent part of the mass. In all other cases of acute appendicitis, and in the majority of the abscess cases, the Kammerer incision should be employed. This consists of an incision over the outer portion of the right rectus muscle about half an inch from its external border. The sheath is divided in the direction of the cutaneous incision and the muscular fibres retracted well inward. This exposes the posterior wall of the sheath, the epigastric vessels, and the last dorsal nerve. These may be retracted or divided and the posterior lamella of the rectus sheath opened, exposing the peritoneum and subserous fat, which is carefully drawn upward and divided. The advantages of this incision are that it admits of enlargement to any extent upward or downward, and when closed by layer suture it leaves almost as firm an abdominal wall as that following the intermuscular operation.

After opening the peritoneal cavity, if no abscess is present, the appendix may be sought for by the finger, or the wound well retracted and the search aided by inspection of the parts. When found, it may be removed and the stump treated as described in the preceding paragraph. The wound is then closed with or without drainage, depending on the presence or absence of necrotic material. Local redness of the intestines, the presence of a fibrinous exudate, or a moderate amount of serous fluid, do not constitute an indication for drainage, as they are but signs of a protective process. When necrotic material is present drainage should be employed by the insertion of a small cylindric roll of gauze surrounded by rubber tissue or drawn through a thin rubber tube made for the purpose. These "cigarette drains" are more effective than any other kind in allowing an exit for inflammatory exudate, and possess the additional advantage that they can be removed with little or no danger to intra-abdominal structures.

If, on opening the abdomen, an inflammatory exudate is found, the surrounding peritoneum is well packed with large gauze pads or masses of loose "handkerchief gauze," and the structures carefully separated in their natural lines of cleavage. As soon as pus escapes, it should be wiped up with sponges, and after enlarging the opening a small syringeful of hydrogen peroxide (1 : 8) injected into the cavity. This blows out the pus by its decomposition and rapid evolution of oxygen gas, and also acts as a disinfectant. When all the pus has been removed, the cavity is wiped dry and the appendix sought for and excised. The cavity should then be freely irrigated with salt solution and temporarily packed with gauze. The abdominal pads are now removed and all soiled towels and sheets taken from the wound-area, which is again surrounded by clean sterilized coverings. The gauze packing is then taken out, all bleeding checked, one or two small cigarette drains introduced, and the wound closed by three rows of sutures, the first including the peritoneum and posterior layer of the sheath, the second the anterior layer of the sheath, and the third the skin. The first two should be of catgut, the last of silk or silk-worm gut.

If, in addition to the localized abscess, there is free fluid in the peritoneal cavity, or if in the course of the manipulations the abscess ruptures and pus escapes downward into the pelvic cavity, this should be cleansed by irrigation with salt solution, and one of the cigarette drains carried to the bottom of Douglas' pouch.

In cases in which the inflammatory process is unlimited by peritoneal adhesions and there is present a diffuse peritonitis, the entire peritoneal cavity should be washed out with an abundance of hot sterile salt solution. This is accomplished best by means of a large Chamberlain or Blake tube and fountain-syringe. Several gallons of the fluid may be allowed to flow through the cavity until it returns clear from every portion. A cigarette drain is then carried to the pelvic floor if necrotic material is present or if the pelvic peritoneum has been the seat of long-standing inflammation. If, on the other hand, the case is operated upon at an early period, and no necrotic material is present, a cigarette drain introduced just within the peritoneal cavity is all that is required.

Post-operative Treatment.—In interval cases and in early acute conditions when the abdomen is tightly closed, little post-operative interference is necessary if the case progresses favorably. Morphine in small doses may be required during the first twenty-four hours to relieve pain. The bowels should be moved on the third or fourth day. For this small doses of calomel should be administered, followed by a saline draught, and enemata if necessary.

If much morphine has been used, there may be considerable difficulty in bringing about a movement, on account of the tendency to nausea which prevents the free use of salts. In these cases the frequent use of high enemata will generally be successful if there is no peritonitis.[1] If the pulse and temperature are normal, the dressing need not be changed for six or eight days. Obstinate vomiting after operation can generally be relieved by lavage, followed by absolute rest of the stomach, not even water being allowed. The practice of giving medicines to relieve post-operative vomiting is to be condemned, as they always serve to aggravate the condition.

Continued pain and vomiting after operation point to peritoneal irritation; and if the pulse and temperature are elevated and the abdominal tenderness, rigidity, and distention are increased, there is strong reason to suspect a spreading peritonitis. In these cases the wound should be reopened under anæsthesia and the peritonitis treated as indicated above. In acute cases in which drainage is employed, the wound should be inspected frequently and the outside dressings changed as often as they become saturated with the wound secretions. If the temperature and pulse remain elevated, and if tenderness and rigidity are present, the drains should be removed and any retained pus evacuated. Digital exploration of the wound with the gloved hand will often enable the surgeon to recognize a collection of pus by the induration, which may not be apparent on superficial abdominal palpation. Such deep-seated collections of pus are often drained best by rubber tubes until the acuteness of the symptoms has subsided. As soon as the sinuses are reasonably clear and granulations appear, further packing is unnecessary and only delays recovery.

In the treatment of a generalized peritonitis the chief indications are to limit the amount of absorption from the peritoneal cavity and to promote rapid elimination. The former is best accomplished by placing the patient in the Fowler position (Fig. 28) to allow the septic material to gravitate toward the pelvis, where absorption is slow; the latter, by introducing into the system large quantities of fluid. At first reliance must be placed upon rectal salines, which should be given slowly at a temperature of 100° F., a short rectal nozzle being employed. Calomel should be administered as soon as the post-anesthetic vomiting has ceased, followed by salines and high enemata. If the medicines are rejected by the stomach, it should be washed out and salts introduced through the stomach-tube. Enemata of turpentine, glycerin, and a saturated solution of Epsom salt should be given. When the rectum becomes intolerant, intravenous infusions are of the greatest value in stimulating the secretion of urine and inducing active diaphoresis. Cardiac stimulants, as strychnine, digitalis, caffeine, and alcohol, should be freely given. Sponge-baths and hot packs will often relieve the intense restlessness and high temperature. The practice of abandoning patients to their fate who develop generalized peritonitis cannot be too strongly condemned. While the great majority of such patients eventually succumb in spite of all treatment, desperate cases occasionally are saved by energetic and persistent treatment. The author has recently seen such a patient recover after days of continuous vomiting of intestinal matter, enormous distention of the abdomen, a temperature of 108.5° F., and a pulse that could not be counted. In this case every available cutaneous vein in the body had been used for saline infusion. Localized abscesses in various parts of the abdominal cavity are not infrequent during convalescence from a diffuse peritonitis. Their presence is indicated by an acute rise in temperature and pulse, a high leucocytosis, prostration, and the occurrence of sweats. The tenderness may be slight even in large collections of pus, and should carefully be sought for by abdominal palpation, vaginal or rectal examination. The symptoms will promptly subside as soon as the focus is located and adequately drained.

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[1] In a recent communication, entitled "Catharsis in Abdominal Surgery," Dr. L. R. G. Crandon, of Boston, condemns the use of cathartic medicines by the mouth in cases of acute abdominal inflammation involving the alimentary canal. He advises high enemata both before and after operation. His best results were obtained by the use of the following formula:

℞ Saturated solution of Epsom salt,
Turpentine,
Glycerin, āā ℥ij.
Water, ℥vj.—M.

Sequelæ of Acute Appendicitis.—Infection from an inflamed appendix may extend along the retroperitoneal lymphatics to the under surface of the diaphragm, giving rise to *subphrenic abscess;* or it may extend upward from the radicles of the portal vein to the liver, and as a result we may have a septic *portal thrombosis* with multiple abscesses of the liver and pyæmia. Gerster and Munro have recently called attention to these conditions, which are not infrequent even after early operation and apparent subsidence of the septic manifestations. These complications would be favored by a rupture of the appendix and the formation of an abscess between the two layers of the mesentery. The treatment of these conditions will be considered elsewhere.

Fecal fistula not infrequently follows appendicitis, especially if the appendix and cæcum are greatly infiltrated and surrounded by an abscess. In these cases removal of the appendix may result in injury to the wall of the gut, and a ligature placed around the stump may cut through before it is tightened sufficiently to occlude the lumen of the tube. Under these conditions a fistula may often be prevented by drawing a piece of omentum over the stump and suturing it to the cæcal wall. The treatment of fecal fistula consists in cleanliness and frequent dressings. Drainage should be removed as soon as the sinus is sufficiently organized to remain patent, and the opening allowed to heal by granulation. The great majority of these cases heal spontaneously.

Ventral hernia frequently follows operations for acute appendicitis, especially if the wound is allowed to remain open for drainage. The treatment is the same as for other varieties of postoperative ventral hernia.

DISEASES OF THE LIVER AND BILIARY PASSAGES.

Ectopic Liver.

The liver may be displaced downward in a condition of general relaxation of the abdominal viscera (Glénard's disease). Hepatopexy, or suturing the liver to the diaphragm or the abdominal wall, or shortening the relaxed ligaments, may be employed to remedy this condition when it gives rise to sufficient discomfort to warrant surgical intervention.

Abscess of the Liver.

Abscess of the liver may arise from trauma; from infection carried to the organ by the hepatic artery in cases of general pyæmia, by the portal vein from infectious processes occurring in the regions drained by the portal system, as appendicitis, dysentery, typhoid fever, and other intra-abdominal or pelvic diseases; or from the biliary passages, as in cases of acute infective cholangitis. Hepatic abscesses may be single or multiple; the former are commonly associated with dysentery, especially the amœbic dysentery of the tropics, and in over 80 per cent. of the cases are situated in the right lobe. Another cause of solitary hepatic abscess is the infection by the blood-current of a pre-existing hæmatoma of the liver, the result of some former injury. Multiple abscesses more frequently follow appendicitis, suppuration of the biliary passages, or conditions of general sepsis. Large single abscesses may result from a coalescence of several smaller foci. They may reach an enormous size, and not infrequently rupture into the peritoneal or pleural cavity, into the lung, or into one of the hollow viscera.

The **symptoms** of hepatic abscess vary greatly, according to the virulence of the infecting agent and the presence or absence of a condition of general sepsis. In the large amœbic abscesses the patient may complain only of a sense of discomfort and weight in the abdomen. Associated with this there are loss of flesh and strength and generally a moderate jaundice. The temperature may remain below 100° F., and the pulse, though weak, may not be rapid. In the majority of instances, however, there are pain and tenderness over the region of the liver, with fever, chills, and sweats. The patient rapidly emaciates and has the appearance of profound sepsis. The liver is enlarged and may be felt as an elastic tumor resembling a cyst. Unless there is a mixed infection, leucocytosis is not present in amœbic abscess of the liver. In abscesses due to pyogenic bacteria the leucocyte count is often high. Rupture of the abscess into the peritoneum or pleural cavity would be followed by symptoms of inflammation of these structures. If rupture occurs into the lung-tissue, large quantities of pus may be expectorated; rupture into the intestine may be followed by rapid relief of symptoms and ultimate recovery. In multiple abscess of the liver the symptoms are those of a grave and rapidly progressing general sepsis. Local symptoms and signs may be absent or there may be pain and tenderness over the hepatic region. One of the most reliable signs is the occurrence of acute, deep-seated pain when the lower segment of the thorax is compressed. The use of an aspirating-needle for purposes of diagnosis is not to be recommended unless one is prepared to operate immediately if pus is found. In certain rare instances an abscess of the liver may give rise to no localizing symptoms or signs, the only evidence of disease being the presence of continued fever.

Treatment.—A liver abscess may be opened and drained through the anterior abdominal wall or through the back by a transpleural operation. Both of these methods are dangerous and unsatisfactory unless adhesions are present. The presence of adhesions to the anterior abdominal wall would be indicated by œdema of the skin and subcutaneous tissues. When this is present, an incision should be made through the tissues to the liver, which may then be aspirated, and if pus is found an opening into the abscess cavity can be made with the cautery or some blunt instrument and a drainage-tube inserted. If no adhesions are present, the abdomen should be opened over the enlarged liver, and if the symptoms are not too urgent, the parietal peritoneum may be stitched to the surface of the liver, the wound packed with gauze, and the opening into the abscess deferred until adhesions have formed shutting off the general peritoneal cavity.

If the case is urgent and rupture is feared, the surrounding peritoneal cavity should be packed with large masses of gauze, the parietes pressed firmly down upon the surface of the liver, and the abscess cavity opened. The pus, if present in large amount, should be siphoned off by means of a long rubber tube, the cavity disinfected with hydrogen peroxide and firmly packed with gauze, the end of which emerges through the abdominal incision. The abdominal packing is then removed and the wound partly closed, in the hope that, by the time it is necessary to remove the gauze from the abscess cavity, adhesions will have formed and contamination of the general cavity be avoided. If the abscess cavity is demonstrated by aspiration to lie posteriorly near the pleural sac, a portion of the eighth, ninth, and tenth ribs may be resected, the parietal pleura stitched to the diaphragm, and the abscess opened immediately; or, if possible, the wound should be packed for forty-eight hours and the opening made after adhesions have formed. Mayo recommends, in suturing the parietal pleura to the diaphragm, that a few layers of sterile gauze be laid over the area to be sutured and the stitches taken through this pad. After adhesions have formed the incision is made directly through the gauze. In about 60 per cent. of solitary abscesses of the liver the pus is sterile (Elsberg). In these cases the prognosis is favorable; in the more virulent cases the outlook is grave.

There is no surgical treatment for multiple abscesses of the liver, except to open and drain the large collections as they are found.

Hydatid Cysts.

These tumors occur more frequently in the liver than in any other organ of the body. They may be single or multiple, and may reach an enormous size. The fluid contained in a hydatid cyst is clear or slightly opalescent, of low specific gravity, contains a trace of salt but no albumin; scolices or hooklets can be found by the microscope. If the cysts are small and deeply seated in the liver, they produce no symptoms. If larger, they produce an enlargement of the organ and give rise to symptoms chiefly of pressure. If larger still and situated near the surface, the globular outline may often be made out and fluctuation sometimes determined. Hydatid fremitus may occasionally be detected by palpation if the cyst lies close to the abdominal wall. It is supposed to be caused by a rubbing together of the daughter cysts, and is appreciated by applying the palm of the hand to one part of the tumor and sharply percussing the mass at another point. It is rarely observed in cases where the amount of fluid is large. Santoni advises auscultatory percussion in these cases, and describes a characteristic sound of low, sonorous quality, which ceases abruptly. Thomas Fiaschi has verified Santoni's observation and regards this sound as of considerable diagnostic importance. If suppuration occurs in one of the cysts, there will be pain, fever, chills, sweats, and prostration.

Treatment.—Aspiration is to be avoided on account of the danger of infecting the peritoneal cavity. The disease may be treated in four ways: complete removal of the cyst with, if necessary, excision of a portion of the liver; emptying the cyst, removal of the endocyst, and stitching the ectocyst to the cutaneous margin (marsupialization); removal of the endocyst and closing the abdominal cavity, allowing the ectocyst to drain into the peritoneum; marsupialization, without removal of the endocyst, and the subsequent employment of solutions of formalin, nitrate of silver or iodine to render the sac and the remaining daughter-cysts sterile. Spontaneous recovery occasionally occurs from death of the organism. This may be favored, as suggested by Fiaschi, by the internal administration of urotropin. In these cases the cyst shrinks, and finally contains only a small mortar-like mass.

Tumors of the Liver.

Angiomata, adenomata, sarcomata, and carcinomata occur primarily in the liver. Small cavernous nævi are not infrequently found on autopsy. They give rise to no symptoms and are of no particular surgical interest.

Adenomata may grow to the size of a small apple. They appear as greenish or whitish firm tumors, and rarely give rise to any symptoms or disturbance of function.

Primary carcinoma of the liver, which is rare, may occur in two forms, one as a group of hard, whitish nodules; the other as a diffuse carcinomatous infiltration of the entire gland. Secondary carcinoma and sarcoma of the liver are of frequent occurrence.

The symptoms of primary sarcoma or carcinoma are a marked but painless enlargement of the liver, which presents a hard nodular surface; jaundice, ascites, anæmia, and progressive loss of flesh and strength. While malignant disease of the liver has, in the past, been regarded as an absolutely hopeless condition, the successful operations by Lin, Keen, Cullen, and many others have demonstrated that the resection of large areas of liver substance is not only technically possible, but is actually accomplished, with a comparatively low death-rate. This fact has encouraged surgeons to advise and practice removal, in the early stage, of primary malignant growths of the liver, when located in an accessible position. The technic of the operation will be described later in the chapter.

Gummata of the liver occur with considerable frequency. Although not a surgical condition, they give rise frequently to symptoms strongly suggesting surgical disease of the gall-bladder and ducts. These symptoms are pain, localized tenderness, and muscular rigidity in the upper right quadrant of the abdomen, with jaundice and occasionally the presence of a tumor. In many cases the diagnosis can only be established by an exploratory laparotomy.

The Surgical Treatment of Ascites due to Cirrhosis of the Liver.

The ascites of cirrhosis of the liver is generally believed to be due to obstruction of the portal circulation. Spontaneous cure has very rarely occurred, and in these cases a subsequent autopsy has demonstrated adhesions and vascular connection between the liver, omentum, spleen, and intestines, and the diaphragm and anterior abdominal wall, allowing the blood from the portal system to gain entrance to the general circulation without passing through the contracted liver. Talma and Rutherford Morison each conceived the idea of favoring nature's methods in these cases by creating adhesions by surgical procedures.

Morison's operation consists in making a median incision through the abdominal wall, opening the peritoneal cavity, and evacuating the fluid. The upper surface of the liver is then rubbed with a pledget of gauze until a raw bleeding surface is produced, and the adjacent surface of the diaphragm is treated in the same manner. The same procedure is next carried out on the external surface of the spleen and its adjacent parietal peritoneum, after which the omentum is stitched to the anterior abdominal wall, the peritoneal surface of which has been similarly freshened. The abdominal wall is then sutured, and a glass drain introduced into the pelvic cavity through a separate incision just above the pubis, through which the accumulating fluid is removed by gauze suction three or four times a day until fluid ceases to be secreted.

Morison obtained two cures of ascites by this method, and since that time several other favorable results have been obtained. A review[1] of all the cases reported in the journals during five years was made by the writer, which showed a mortality of 37 per cent., with 10 per cent. of cures and 20 per cent. of marked improvement. Greenough subsequently collected 105 operations which showed a death-rate of about 30 per cent. and less than 10 per cent. of cures. Narath and others have modified the operation with a view to lowering the mortality. At present most surgeons simply evacuate the fluid, implant a portion of the omentum between the peritoneum and the rectus muscles, close the abdomen tightly, and depend upon subsequent tappings to remove the fluid which accumulates while the adhesions are being formed. The operative risk from this procedure is low. As experience has shown that these cases almost invariably die within a few months after the appearances of the ascites, the results of the operation would seem to warrant its continued trial.

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[1] "The Surgical Treatment of Ascites Due to Cirrhosis of the Liver," *Medical News*, Feb. 8, 1902.

Cholelithiasis.

Cholelithiasis, or the presence of gall-stones in the biliary passages, is of frequent occurrence; according to Reidel and Kehr, they are found in 10 per cent. of all adult autopsies. Gall-stones are composed of crystals of cholesterin held together by mucus and colored by bile-pigment. They may occur singly or in any number. They may be rough, irregular in outline, and of a dirty-brown color; or they may be smooth, faceted, and of a yellowish satin-like lustre. In the great majority of instances they are formed in the gall-bladder, presumably as a result of some mild infection of the mucous membrane, giving rise to the secretion of a changed mucus which acts as a cement-substance and binds the precipitated crystals of cholesterin together. Exceptionally, biliary concrements may form in the bile-ducts; these are generally softer, darker in color, lustreless, and appear to be composed of inspissated bile. The writer has once seen the gall-bladder and cystic duct completely filled with this material, which had the consistency of putty.

Gall-stones may occur at any age, but they are commonest in adults, and are more frequent in women than in men. Sedentary habits, overeating, and digestive disturbances act as predisposing factors.

Symptoms.—In 95 per cent. of the cases the presence of gall-stones gives rise to no symptoms (Kehr); in the remaining 5 per cent. symptoms are produced which vary in intensity and importance from a slight discomfort in the right hypochondriac region to a rapidly fatal septic peritonitis.

One or more stones in a healthy gall-bladder with patent ducts produce, as a rule, no symptoms, and under these conditions the only physical signs present may be those of a tumor of the gall-bladder, caused by the number or size of the calculi.

If, however, a calculus becomes impacted at the neck of the gall-bladder or in the cystic duct, or if the mucous membrane of the gall-bladder becomes inflamed, symptoms are produced. In the former instance, pain of a moderate, paroxysmal character may be present, due to the expulsive efforts of the organ to rid itself of the obstruction, or to a gradual distention of the viscus with mucus; in the latter, to distention of an inflamed and sensitive organ. Kehr believes that the pain in these cases is practically always the result of inflammation. It frequently begins at night, and this circumstance seems to distinguish it from the pains of gastric ulcer or other digestive disorders, which begin, as a rule, soon after a meal.

The pain originating in the gall-bladder varies considerably in intensity, but presents two fairly uniform characteristics: it is situated in the upper right quadrant of the abdomen, and generally extends through to the back and upward to the region of the scapula and shoulder. Tenderness is rarely present in the absence of inflammation; but when present it is immediately over the organ, which usually is found behind the right rectus muscle, just below the free border of the ninth rib.

Tumor of the gall-bladder, present under the conditions enumerated above, from the large size or number of the gall-stones or from an accumulation of fluid is usually more easily defined than in inflammatory conditions, on account of the absence of a pericystic exudate and of rigidity of the abdominal wall.

The presence of a number of stones in a gall-bladder has occasionally been recognized during palpation by a *bruit*, which, according to Petit, resembles the rubbing together of nuts in a bag.

If, however, the stone becomes impacted in the cystic duct, or if the duct becomes permanently obstructed in any other manner, as by a new growth or cicatricial contraction, there occurs a gradual increase in the size of the gall-bladder by an accumulation of fluid within its cavity. In the absence of infection this fluid is sterile, and consists of a thin mucus secreted by the mucous membrane, which gradually distends the gall-bladder, often to an enormous size, giving rise to no discomfort excepting that produced by pressure from the size of the tumor. In this condition of *hydrops of the gall-bladder* the walls of the viscus become extremely thin; the fluid is at first bile-stained, but later becomes cloudy and often opalescent. A tumor of this character develops slowly, is situated immediately behind the abdominal wall, below the free border of the ribs on the right side, and appears continuous with the liver at a point opposite the junction of the ninth rib with its cartilage. It develops downward and somewhat toward the median line; it moves with respiration, and may permit a lateral, pendulum-like motion on palpation. It is generally smooth, of even oval contour, and its consistence may be soft, hard, fluctuating or elastic. It may be of interest in this connection to note that the gall-bladder has occasionally been found near the median line (Kehr), or under the free border of the ribs on the left side, as reported by Raymond and Carl Beck. Congenital absence of the gall-bladder has been observed once by the writer; and Courvoisier refers to a case in which it was apparently absent, but in reality was deeply imbedded in the substance of the liver.

The passage of small stones through the cystic duct may give rise to no painful symptoms. Lawson Tait, however, expressed the belief that they cause far more pain than when passing through the large common duct; and Kehr has made a similar statement.

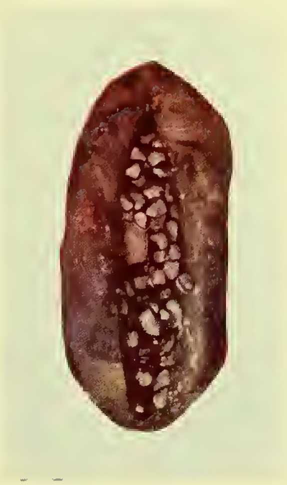
The diagnosis of stone in the hepatic duct is often very difficult. Pain is usually present, but of no constant type, and occasionally is accompanied by digestive disturbances and vomiting. Enlargement of the liver, jaundice, and fever may occur.

The diagnosis of stone in the common duct is less obscure; the three most prominent symptoms are jaundice, pain, and fever. Practically all observers regard jaundice as the most constant and reliable symptom of obstruction of the common duct. When this symptom is due to calculus the diagnosis is comparatively easy; when due to other forms of obstruction it is often extremely obscure. Acute temporary common-duct obstruction from stone produces a rapidly developing jaundice, which as rapidly subsides when the stone passes into the duodenum. When the stone becomes impacted in the region of the papilla, the jaundice is progressive and often becomes extreme. If, however, the dilatation of the duct above the obstruction, from an accumulation of bile, causes the stone to become dislodged, and it floats upward in the dilated common cystic or hepatic duct, the obstruction is temporarily removed, the bile again flows into the intestine, and the jaundice disappears, only to recur when the duct contracts around the stone or it is impacted again at the papilla.

Pain in common-duct obstruction strongly points to stone. In intermittent obstruction from a floating stone it is generally more acute during the period of obstruction. It is then often paroxysmal in character, radiates to the back and shoulder; rarely is it constant and fixed in one locality. Tenderness is generally more marked nearer the median line, and slightly higher than when the gall-bladder is the seat of the trouble.

Fever is less constantly present; but when present is generally of a characteristic type. It is often intermittent in character, and is accompanied by chills and profuse sweats. This type of fever is described by Charcot as *fièvre intermittente hépatique*, and its similarity to malaria has been pointed out by many other observers. When present with jaundice and colic, it is almost pathognomonic of stone of the common duct. Although believed by many to be reflex or due to the absorption of bile, the ma-

PLATE XI



Subacute Cholecystitis with Gallstones.

Colored photograph of specimen from patient in the Roosevelt Hospital.
(Lumiere process.)

jority of modern observers agree with Schuppel in regarding it as of septic origin, as the presence in these cases of a certain degree of cholangitis is practically constant.

When the flow of bile into the intestine is hindered, the urine will be dark from the presence of pigment; when completely obstructed, the stools will be clay colored.

Tumor of the gall-bladder is generally absent. It, however, has occasionally been observed. Enlargement of the liver is frequent, and is due to the dilated intrahepatic ducts or to an extension upward of the cholangitis, in which case there will be tenderness over the liver and enlargement of the spleen. Ascites is present only when the obstructing stone is large and presses on the portal vein.

Treatment.—The mere presence of gall-stones in the bladder, producing no symptoms, calls for no treatment. If, however, they give rise to a cholecystitis or to obstruction of the ducts, they should be removed. The treatment of an acute attack of biliary colic should consist in a hot bath, followed by morphine administered hypodermically, and the application of an ice-bag to the region of the liver.

Cholecystitis and Cholangitis.

Inflammation of the gall-bladder or ducts is present in the vast majority of patients who apply to the surgeon for relief.

Whereas it was formerly believed that biliary colic was due simply to the passage of a calculus from the gall-bladder through the narrow ducts to the intestine, most surgeons now regard this symptom as the expression of an inflammatory process in these organs. Kehr states that, in his opinion, colic is practically always due to an inflammation of the gall-bladder, and this view is expressed also by many other observers.

Infection of these organs arises generally from an upward extension from the intestine from an abnormal patency of the duodenal orifice, occasionally from some general septic disease, very rarely from trauma. Inflammation of these organs may be conveniently divided into two classes—the mild and the severe infections: the former due to the colon or typhoid bacillus; the latter, to the streptococcus or some other equally virulent organism. In the great majority of instances cholelithiasis has preceded the inflammation and prepared the way for it.

The **symptoms** of cholecystitis are pain, tenderness, fever, and the presence of a tumor of the gall-bladder.

In a mild infection of the organ with the ducts open, insuring free drainage into the bowel, these symptoms may be wanting.

If the cystic duct becomes obstructed from stone or swelling of the mucous membrane, colicky pains occur, which may radiate to the back and shoulder; vomiting is generally present during the period of obstruction; there are also usually slight fever and general malaise, which disappear with the pain when the obstruction is relieved. Unless the gall-bladder be small or deeply seated under the right lobe of the liver, a sensitive tumor may be felt during the continuance of the obstruction. These symptoms frequently subside spontaneously, but the tendency to recurrence is marked.

If chronic obstruction of the cystic duct occurs, empyema of the gall-bladder results, giving rise to symptoms of varying severity according to the virulence of the infecting agent or the resistance of the individual. The pain and fever may be wanting, the only symptoms being the presence of a tender tumor in the gall-bladder region; or, in cases of a small or contracted gall-bladder, only a local tenderness or muscular rigidity. In the severer cases the pain is acute, paroxysmal, and radiating; the fever is high, and is accompanied by chills and vomiting. A local peritonitis may be present, a condition often resembling appendicitis. In the more virulent infections the symptoms often develop with great rapidity, and are accompanied by marked prostration and a rapidly developing sepsis. Perforation of the gall-bladder with a fulminating, fatal, septic, general peritonitis has been reported in a number of instances. Jaundice is absent in cholecystitis unless the tumor of the gall-bladder or cystic duct presses upon the common duct.

In inflammation of the common or hepatic ducts, however, jaundice is often present in addition to the pain and fever; but unless accompanied by stone or complete obstruction from other causes it is seldom of a severe type. In the more virulent infections of the common and hepatic ducts the process extends rapidly to the intrahepatic branches, and gives rise to general sepsis, often without other symptoms, leading, unless speedily relieved by surgical means, to multiple hepatic abscesses and death. This condition is practically always accompanied by the presence of foreign bodies in the ducts or gall-bladder.

Treatment.—Mild cases of cholecystitis should be treated by rest, an ice-bag to the tender region of the abdomen, and free catharsis. If the pain is severe, it may be necessary to relieve it by the use of morphine or other forms of opium. Although the gall-bladder seldom ruptures spontaneously, infection of the peritoneal cavity may occur without rupture and lead to a spreading peritonitis and grave sepsis. For this reason operative treatment is indicated if the symptoms do not promptly subside as a result of the treatment outlined above. If the cholecystitis is acute and the ducts are patent, cholecystostomy will give prompt relief; if the condition is a chronic, relapsing one with an occluded cystic duct, and a shrunken, functionless gall-bladder, cholecystectomy is to be recommended.

In cases of suppurative cholangitis, which are practically always associated with stone or other foreign bodies in the ducts, removal of the foreign body and drainage of the common and hepatic ducts by means of a rubber tube, is the only method of treatment that holds out any hope of success.

Tumors of the Gall-bladder and Ducts.

While new growths of neighboring organs not infrequently produce symptoms referable to the gall-bladder or ducts by external pressure or direct extension, primary new growths in these organs are exceedingly rare.

The gall-bladder is most frequently affected, and in the great majority of instances the growth is *carcinoma.* This disease was observed, according to Courvoisier, in 7 in 2520 autopsies. Three-fourths of the cases occur in women. Seven-eighths of all the cases occur in subjects of cholelithiasis.

The early **symptoms** are generally those of disturbed digestion and malnutrition. Vomiting, colic, jaundice, and ascites may be present. Kehr states that the last two symptoms always result from involvement of the portal glands, causing pressure on the ducts and portal vein.

The **diagnosis** is, in the early stage of the affection, often difficult, as the symptoms are largely due to associated gall-stones or cholecystitis. At a later period the anæmia, loss of weight and strength, and the presence of a hard nodular tumor in the region of the gall-bladder lead generally to a correct diagnosis.

The disease is rapidly fatal; in 53 cases followed to the end, death occurred in all within nine months from the onset of the first characteristic symptoms.

The occurrence of both *benign* and *malignant tumors of the bile-ducts* has been reported by Mayo-Robson and others. The symptoms at first are those of duct obstruction from other causes, and the malignant varieties are later accompanied by malnutrition, progressive asthenia, and cachexia.

Chronic obstruction of the common duct from outside pressure of tumors of the pylorus, duodenum, or *head of the pancreas,* is of fairly frequent occurrence. As would be expected, the cardinal symptom is a progressively increasing jaundice, without fever and with little or no pain. In these cases there is a gradual enlargement of the liver and gall-bladder, with ascites.

The same symptoms may be occasioned by a tumor within the duct. Intermittent jaundice has rarely been observed in such cases, probably due, as suggested by Haarimann, to sloughing of a part of the obstructing mass, allowing a temporary flow of bile into the intestine; or, as reported by Courvoisier, a pedunculated tumor near the papilla may act as a valve and occasionally permit the passage of bile.

Treatment.—Carcinoma of the gall-bladder, if discovered early, should be completely removed by cholecystectomy, including a considerable area of the underlying liver, if this is at all involved. Benign tumors of the ducts may occasionally be removed surgically. Carcinoma of the common bile-duct, when small, can be removed by excision of the diseased area, followed by an end-to-end anastomosis or by implantation of the proximal extremity of the duct into the duodenum. More advanced cases of duct cancer and inoperable tumors of other organs producing permanent occlusion of the common duct should be treated palliatively by cholecystenterostomy or anastomosing of the gall-bladder to the duodenum, jejunum, or colon.

OPERATIONS ON THE LIVER, GALL-BLADDER, AND DUCTS.

Resection of the Liver.

This operation is undertaken for the removal of primary malignant growths, small echinococcus cysts, or hopelessly injured areas. It is generally advisable to remove a triangular area, the base of which correponds with the free edge. Two long-bladed stomach or intestinal clamps are applied just beyond the area to be removed. The clamps should have moderately flexible blades covered with rubber tubing to prevent injury to the liver tissue. After application of the clamps the pathologic area is excised with a scalpel and the visible bloodvessels clamped and ligated. Several deep mattress sutures are then passed, about one inch from the incised border, and, after removal of the clamps, the cut edges are pressed together and the mattress sutures tied. In passing the sutures only a blunt needle should be employed, and the suture material should be heavy, plain catgut. If no bleeding occurs, the peritoneal cavity may be closed without drainage.

Cholecystotomy.

Cholecystotomy consists in opening the gall-bladder for purposes of exploration or for the removal of a foreign body.

The abdomen should be opened by a longitudinal incision near the outer border of the right rectus muscle, extending from the cartilage of the eighth rib to a point opposite the umbilicus. The gall-bladder is drawn upward into the wound and the peritoneum protected by gauze pads. An incision is made in the fundus, and the foreign body removed, after which the opening is closed with two rows of Lembert sutures, the parts disinfected, and the gall-bladder returned to the abdominal cavity, which is closed by layer suture.

Cholecystostomy.

In cholecystostomy for drainage of the gall-bladder the viscus is exposed as in cholecystotomy. Two circular purse-string sutures are introduced into the peritoneal covering of the fundus of the gall-bladder, the first making a circle about one-third inch in diameter, the second surrounding the first and about one-third inch from it. An incision is then made within the inner circle and a rubber drainage-tube introduced. As the tube is being passed into the bladder the first suture is tightened and knotted; the tube is then pushed further inward, carrying with it a funnel-like depression of the fundus, as the second suture is tied. The abdominal wound is then partly closed and the gall-bladder attached to the parietal peritoneum by one or two catgut sutures. The advantage of this method is that after the wound has healed there is practically no leakage when the tube is removed, and a permanent and lasting fistula is thereby avoided.

This method may be carried out even after large incisions in the gall-bladder for the removal of stones, etc., by the introduction of a few more sutures.

Cholecystectomy.

In this operation the gall-bladder is exposed as in the other operations, the cystic duct located, freed from its peritoneal coverings, and double ligated with silk or heavy chromicized catgut. The cystic artery, which lies just behind the cystic duct, should then be exposed and tied. The gall-bladder is next separated from the under surface of the liver by blunt dissection, after first incising its peritoneal coverings at its junction with the liver. When the gall-bladder is thoroughly separated from the liver the cystic duct is divided between the two ligatures and the organ removed. Hemorrhage should be arrested by ligating any bleeding points and by gauze packing pressed against the raw surface of the liver. The abdominal wound is then partly closed, leaving a gauze or cigarette drain next to the liver wound.

Choledochotomy.

In choledochotomy, or opening one of the bile-ducts for the removal of a stone or for drainage, a large abdominal incision should be made through the right rectus muscle, extending as high as possible. If the abdominal wall is thick, the S-shaped incision of Bevan will give an excellent exposure. It is made by adding an oblique inward cut to the upper, and an oblique outward cut to the lower end of the regular straight rectus incision. When the gall-bladder region is freely exposed and the intestines well walled off by large masses of handkerchief gauze, the operator introduces his left hand deeply into the wound and carries the index finger into the lesser peritoneal sac through the foramen of Winslow. With the forefinger in the foramen and the thumb above the free edge of the lesser omentum, the hepatic, cystic, and common ducts may easily be palpated as far as the pancreas. If a stone is detected, the duct is raised with the underlying finger, and brought as near the surface wound as possible. The stone is recognized, and after the duct is freely exposed by removal of the peritoneal covering it is incised longitudinally and the stone removed. A probe should then be passed upward and downward to insure patency of the remaining portions of the duct. If there is no reason to suspect infection of the ducts (cholangitis), the wound in the duct may be closed by fine silk sutures introduced with a small round curved needle. The introduction of duct sutures is greatly facilitated by the employment of Halsted's hammer, which dilates the lumen of the duct and allows greater accuracy in applying the sutures. Mayo closes the wound in the duct by introducing two catgut sutures longitudinally, one on either side of the incision. By tying the upper and lower extremities of each suture across the incision, the wound edges are brought in apposition. A small wick of gauze is then carried down to the wound and held in place by again tying the uncut ends of the catgut over the gauze wick. If there is reason to suspect an infective cholangitis, a small rubber drainage-tube should be introduced into the hepatic portion of the duct and held in place by a single catgut suture. This is surrounded by a generous packing of sterile gauze, and the wound partly closed. When the duct wound has been sutured, a cigarette drain should be introduced before the abdominal wound is closed, the rubber part of which only should be left in contact with the line of suture.

Duodenotomy.

Duodenotomy, for removal of a stone in the lower third of the common duct, has been recommended by McBurney as an easier and safer method than by exposing the duct at this part. An incision is made in the second portion of the duodenum, parallel with the long axis of the bowel, the position of the stone recognized by palpation and inspection, and its removal effected by an incision through the mucous membrane into the diverticulum of Vater or the duct. The external duodenal wound is then closed by two rows of Lembert sutures, the surrounding parts carefully disinfected, and the abdominal wound partly closed with drainage.

Cholecystenterostomy.

This operation is indicated in any case of inoperable, complete, and permanent obstruction of the common duct. When possible, the fundus of the gall-bladder is anastomosed to the second portion of the duodenum. When this is impossible on account of adhesions, or a misplaced or small gall-bladder, union with the stomach, the jejunum, or even with the hepatic flexure of the colon, may be made. The best method of effecting this anastomosis is by the use of a small Murphy button, the technic of which has already been described. After the two halves of the button have been joined the line of union may be protected and strengthened by wrapping it with a mass of omentum and securing it in place by two or three catgut sutures.

In all operations upon the bile-ducts it should be remembered that a pad or cushion, placed beneath the lower dorsal region, will increase to a considerable extent the exposure of the parts.

DISEASES OF THE PANCREAS.

Pancreatic Hemorrhage.

The possibility of severe and often fatal spontaneous hemorrhage from the pancreatic vessels has been recognized for years. To this condition the term *pancreatic apoplexy* has been applied. Pancreatic hemorrhage, however, is more often the result of an inflammatory process and an extensive fat necrosis of the organ and surrounding tissues, and is, therefore, one of the symptoms of acute pancreatitis.

Symptoms.—The symptoms of a spontaneous pancreatic hemorrhage are epigastric pain, followed by pallor, weakness, rapid heart action, cold perspiration, air hunger, and great restlessness.

The patients become rapidly exsanguinated, and not infrequently die in a few hours, before a diagnosis is made.

Treatment.—The treatment should be laparotomy, removal of clots, and arrest of the hemorrhage by ligation of the bleeding vessels or generous gauze packing.

Acute Pancreatitis.

This disease was first accurately described by Fitz in 1899, in his Middleton-Goldsmith Lectures. On this occasion he called attention to the fact that the disease may assume three distinct types: the hemorrhagic, the suppurative, and the gangrenous. Since that time a great deal of attention has been given to the subject both by pathologists and clinicians, and many additional facts have been collated regarding its etiology and clinical history. It is now generally conceded that the disease is essentially a surgical condition, as operation furnishes the only means of successfully meeting the indications in any of its severer types.

The most important etiologic factor in acute pancreatitis is the escape of pancreatic fluid from the duct or its radicles into the parenchyma of the gland or the surrounding areolar tissue and fat. This, by its fat-splitting ferment, gives rise to a more or less extensive fat-necrosis in the surrounding tissue. If this necrosis extends to and involves the bloodvessels, hemorrhage may result, *hemorrhagic pancreatitis:* or if there is present in the ducts an infection, suppuration may occur in the necrosed area, giving rise to multiple abscesses in the gland, peripancreatic abscess with a spreading peritonitis, *suppurative pancreatitis,* or extensive gangrene of the gland or periglandular fat, *gangrenous pancreatitis.* As the pancreas is richly supplied with large bloodvessels, the hemorrhage frequently is very severe, and occasionally death results in a few hours. In other cases the blood and pancreatic fluid escape into the lesser peritoneal cavity, producing symptoms of severe shock, from which the patient may slowly recover; or the extravasated blood and pancreatic juice may become infected and produce eventually a subphrenic abscess. The two most important causes of a leakage of pancreatic fluid are trauma and occlusion of the duodenal orifice of the canal of Wirsung. The frequent association of this disease, therefore, with cholelithiasis has been mentioned by Opie and others. Lodgement of a gall-stone in the lower part of the common duct or in the diverticulum of Vater will occlude not only the common bile-duct, but also the canal of Wirsung. If in these cases the duct of Santorini is not patent, backing up of the pancreatic juice will occur and rupture of some part of the duct system be rendered probable.

If the stone plugs only the duodenal orifice of the diverticulum, but does not completely fill it, bile may be regurgitated into the pancreatic duct. This has been shown by Opie to be capable of producing acute pancreatitis both in animals and in the human subject. As there is practically always a certain amount of cholangitis present when gall-stones have occupied or passed through the common duct (due largely, the author believes, to a chronic dilatation, and absence of sphincteric action of the duodenal orifice, from the previous passage of stones), it is reasonable to suppose that this condition is generally present also in the canal of Wirsung, and may, as Robson has suggested, often give rise to symptoms of mild pancreatitis even when the ducts are patent. When, however, for any reason the pancreatic duct becomes occluded, an active inflammatory process is lighted up, and if extravasation of the backed-up fluid occurs, an acute pancreatitis usually results.

Symptoms.—Clinically, pancreatitis may be divided into three classes: *catarrhal* or *subacute* pancreatitis, *parenchymatous* or *acute* pancreatitis, and *interstitial* or *chronic* pancreatitis.

The symptoms of *catarrhal* pancreatitis are indefinite. There may be moderate pain or discomfort in the epigastric region with anorexia and nausea. As it is frequently associated with obstruction of the common bile-duct, there is icterus, associated with the passage of large, light-colored stools containing free fat and undigested meat-fibres. There is generally a rapid loss of weight. Robson has recently stated that in his opinion a large number of the cases of so-called catarrhal jaundice are due, not to a catarrhal cholangitis, but to a catarrhal pancreatitis, with œdema of the head of the pancreas compressing the common duct. His opinion is based upon the fact that he has often demonstrated this condition at operation, and also upon the fact that the Cammidge pancreatic reaction is frequently present in these cases.

The symptoms of *acute* parenchymatous pancreatitis vary considerably with the type of the disease. In the hemorrhagic variety there may be the sudden occurrence of an acute abdominal pain located in the epigastric region, followed immediately by symptoms of rapid collapse. There may be no other symptoms and death may take place in a few hours. In milder cases the pain may be as severe, but the shock less marked. The patient may present the appearance of a serious loss of blood—pallor, cold extremities, restlessness, cold perspiration, subnormal temperature, and a rapid, feeble pulse; but from this he may slowly recover and later present evidences of an epigastric peritonitis. As the disease progresses, a tumor may be felt in the region of the pancreas; or there may be evidences of extensive suppuration, as chills, sweats, high fever, and a marked leucocytosis.

In the suppurative or gangrenous types the initial shock may be absent; pain, tenderness, muscular rigidity, and evidences of sepsis are present. In suppurative disease of the ducts with multiple abscess of the gland the only symptoms may be those of a rapidly progressive general sepsis.

The other conditions which may produce an epigastric peritonitis are perforation of a gastric or duodenal ulcer and suppurative disease of the gall-bladder or ducts. Lund states that the tenderness and muscular rigidity are less marked in pancreatitis than in gastric ulcer. In acute cholecystitis with or without rupture, the pain and point of greatest tenderness are at first well to the right of of the median line; while in acute pancreatitis they are at the median line or somewhat to the left. A positive diagnosis is rarely possible in an acute epigastric peritonitis without exploration. After the abdomen is opened the occurrence of numerous small white areas of fat-necrosis in the omentum is pathognomonic of pancreatitis.

Treatment.—Except in the milder cases which do not present evidences of severe shock, and in which improvement rapidly follows rest and expectant treatment, all cases of possible acute pancreatitis should be subjected to operative treatment unless the shock or general sepsis is such as to preclude the possibility of administering a general anæsthetic. Even in these cases an exploratory incision under cocaine may be undertaken. The abdomen should be opened in the median line above the umbilicus, and the pancreas exposed by tearing through the greater or lesser omentum. Clots or gangrenous masses, if present, should be removed, hemorrhage arrested by gauze packing, localized collections of pus opened, disinfected with hydrogen peroxide and packed, larger areas of suppuration treated as intra-abdominal abscesses from other causes. If possible, deep-seated suppuration should be drained through the back. Owing to the anatomic arrangement of the connective-tissue planes about the pancreas suppuration in this region tends to burrow toward the left flank, and should therefore be drained in this region. In certain early cases the pancreas may simply appear acutely inflamed and œdematous. In these cases incisions should be made through the capsule and gauze drainage employed. At a later period gangrenous areas separate and should be removed.

The disease, unless treated surgically in the earlier stages, is an exceedingly fatal one. This, however, should not deter the surgeon from operating late, as brilliant results a reoccasionally achieved by thorough operation and energetic post-operative stimulation.

Chronic Pancreatitis.

Chronic pancreatitis is usually an interstitial inflammation resulting in a localized or general cirrhosis of the gland, due generally to a long-continued infection of the canal of Wirsung and its branches. Opie describes two types, the *interlobular* and the *interacinar*. Both give rise to an overgrowth of the connective tissue of the gland; but the latter, by a gradual pressure atrophy of the islands of Langerhans, causes diabetes. The disease occurs generally in the head of the pancreas, but may occur in any other part of the gland, and is characterized by a general hardening of the tissues without enlargement.

The condition has been extensively studied by Kehr, Moynihan, and Mayo-Robson, who recognize in it one of the causes of chronic obstructive jaundice.

Symptoms.—The disease, as a rule, gives rise to no pain or sign of inflammation. Usually there is a history of cholelithiasis or of several slight attacks of pain and tenderness in the epigastric region. When the head of the pancreas is the seat of the lesion, the two chief symptoms are progressive jaundice and rapid loss of weight. As these symptoms are also the chief symptoms of early carcinoma of the head of the pancreas, a differential diagnosis between the two conditions is often impossible, even after an exploratory operation, as in each there is a hard, easily palpable fixed tumor behind the pylorus in the concavity of the duodenum. As in other cases of complete obstruction of the bile and pancreatic ducts, the stools are large, clay colored, contain undigested meat-fibres, and often appear opalescent from the presence of fat. The urine is concentrated and highly colored from the contained bile. Glycosuria occasionally is observed. Robson and Moynihan have recently called attention to the Cammidge reaction of the urine as an important aid to diagnosis in chronic pancreatitis. For a description of the technic of this test the reader is referred to the original paper by Cammidge.[1]

Moynihan also states that in his experience the jaundice of chronic pancreatitis is a lighter yellow than in carcinoma. In the latter condition the color is deeper and presents a more greenish hue.

Treatment.—The curative effect of cholecystenterostomy and of simple cholecystostomy has been demonstrated in a number of cases reported by Robson and others. On account of the difficulties and frequent errors in diagnosis, all cases of supposed carcinoma of the head of the pancreas should be given the benefit of one of these procedures.

[1] "Lancet," March 19, 1904.

Cysts of the Pancreas.

Cysts of the pancreas may occur at any age. They may reach an enormous size, giving rise to large globular swellings in the epigastric and left hypochondriac regions. The majority of these cysts which have been examined histologically belong to the cyst-adenomata. Formerly they were supposed to be due to obstructive disease of the pancreatic duct or of one of its branches. Experiments upon animals have, however, shown that obstruction of the duct is frequently followed by atrophy of the gland rather than the formation of a retention-cyst. The canal of Wirsung is occasionally dilated as a result of obstructive disease, but it rarely reaches a large size and, as a rule, gives rise to no symptoms. Virchow designated this dilatation of the duct as *ranula pancreatica.*

Moynihan states that a congenital cystic disease of the pancreas, similar to that found in congenital polycystic kidney, occasionally is observed; also that cystic degeneration of a malignant tumor may be present. Hemorrhagic cysts in the substance of the gland occasionally develop after spontaneous or traumatic hemorrhages.

A large number of the so-called cysts of the pancreas are in reality not cysts in a strict histologic sense, but collections of fluid distending the lesser peritoneal sac from rupture of the pancreas. Jordan Lloyd has studied these *pseudo-cysts,* and states that they may contain fluid capable of converting starch into sugar, and that the presence of this ferment is due to a wound of the duct system of the gland.

The **symptoms** of a pancreatic cyst are simply those of a slowly growing epigastric tumor. There is, as a rule, no pain; but there may be a considerable loss of flesh from the digestive disturbances incident to an absence of pancreatic secretion in the cases in which total obstruction exists. The tumor is globular, elastic, and often fluctuating. It lies behind the stomach and transverse colon, and may therefore be covered by a tympanitic area. Sometimes the tumor in its growth separates the stomach and colon, or reaches the anterior abdominal wall from beneath the colon. In these cases flatness on percussion may be present. A specimen of fluid withdrawn by an aspirating-needle usually establishes the diagnosis by exhibiting the chemical reactions peculiar to the pancreatic secretion. This, however, is not always true in the cyst-adenomata, as evidenced by a case recently reported by Ransohoff.

Treatment.—Removal of these cysts is generally out of the question on account of their anatomic relations. They should therefore be opened, the contents evacuated, and permanent drainage established by stitching the cyst-wall to the abdominal incision. Numerous cases have been cured by this method, although the secretion may continue for many months. A disagreeable feature of the treatment is the occurrence of an obstinate dermatitis around the fistulous opening, due to the corrosive action of the pancreatic fluid. In a certain proportion of the cyst-adenomata complete extirpation is possible, and this is, of course, the ideal method of treatment.

Carcinoma of the Pancreas.

Primary carcinoma of the pancreas is occasionally encountered, and when present generally affects the head of the gland. The organ is more frequently involved secondarily as a result of extension of the disease from the stomach or some other neighboring structure.

The **symptoms** of this condition are a progressive loss of weight and strength, accompanied or followed by jaundice and intense itching of the skin. The jaundice is similar in its behavior to other varieties of jaundice caused by a complete and permanent obstruction of the common duct in that it is progressive, without remissions, and is unaccompanied by colic.

The **diagnosis** of carcinoma of the head of the pancreas is not always clear. In the presence of a progressively increasing jaundice with loss of flesh and strength, one must consider three conditions—an impacted stone in the common duct, chronic interstitial pancreatitis, and carcinoma. Stone would be indicated by a previous history of biliary colic, with or without attacks of transitory jaundice, by the occurrence of pain at the beginning of the present attack, and by the absence of a gall-bladder tumor. Chronic pancreatitis, on the other hand, would not necessarily be associated with a history of previous calculous disease of the biliary passages, although that association is frequently present. Pain never occurs as a symptom at the beginning of a jaundice due to duct closure from chronic pancreatitis or cancer. In carcinoma of the head of the pancreas there is rarely a history of cholelithiasis, and the loss of flesh and strength may precede development of the jaundice. There is, moreover, as a rule, a gall-bladder tumor due to distention of the viscus with bile. Enlargement of the liver and ascites are generally present late in the disease, the former due to dilatation of the intrahepatic bile-ducts, the latter to pressure on the portal vein. The disease occurs late in life.

The **treatment** of this condition can only be palliative. In certain cases, seen early, cholecystenterostomy may relieve the jaundice and intense itching of the skin ; but this or any other surgical operation in these individuals is accompanied by great risks, as their natural resistance is very much reduced.

DISEASES OF THE SPLEEN.

Ectopic Spleen.

The spleen may be displaced and occupy almost any position in the abdomen. The causes of this condition are obscure.

Symptoms.—There may be no symptoms; or the wandering spleen may cause displacement of the stomach and occasion pain and vomiting; it may give rise to intestinal obstruction by pressure on the bowel, or by the formation of adhesions may give rise to a kinking of the gut and strangulation. In a case observed by the writer the spleen was situated in the pelvic cavity, and was firmly adherent to the sacrum, rectum, and bladder, producing symptoms referable entirely to the bladder. In this case there was also axial rotation, the internal surface pointing toward the left and the anterior border being downward. Rotation of the spleen with twisting of the pedicle, causing strangulation of the vessels, may give rise to acute pain, vomiting, tenderness, peritoneal irritation, and result in gangrene of the organ.

The **diagnosis** occasionally is made by the shape of the tumor, by the recognition of its notched anterior border, and by the fact that frequently it can be reduced to its normal position.

Treatment.—Splenopexy, or suturing the organ to the diaphragm or posterior abdominal wall, has been recommended. Rose and Carless recommend making a bed for the wandering organ in the retroperitoneal space near its normal habitat, withdrawing it through an incision in the parietal peritoneum, and securing it by sutures. Splenectomy is, however, the operation of choice. Of 16 cases of splenectomy for this condition cited by Osler, 15 recovered.

Abscess of the Spleen.

Abscess of the spleen is exceedingly rare, and generally is metastatic in origin. It is often associated with some acute infectious disorder, as typhoid fever, small-pox, acute rheumatism, or gonorrhœa.

The association of malaria with abscess of the spleen has been mentioned by a number of observers. Trauma has been recorded in a few instances, especially when the spleen subsequently became adherent to a loop of damaged intestine. In a fair number of cases the disease seems to result from an infection of a preëxisting hæmatoma.

Symptoms.—The symptoms of splenic abscess are pain and tenderness in the left hypochondriac region, muscular rigidity, fever, chills, and leucocytosis. As adhesions frequently form between the spleen and the parietal peritoneum of the diaphragm and abdominal wall, symptoms of pleurisy or infection of the abdominal parietes develop.

Treatment.—The treatment should be incision and evacuation of the pus. If pointing occurs on the surface of the body the incision should be over the inflamed area. If no such sign exists, laparotomy is indicated with drainage, as in other intra-abdominal abscesses.

Tuberculosis of the Spleen.

A number of cases of splenic tuberculosis have been recorded, in some of which the disease was apparently primary. The spleen in this condition is generally enlarged, and more or less discomfort and pain is present.

Bland-Sutton and others have successfully removed the spleen for this disease, with complete restoration to health.

Tumors of the Spleen.

Primary sarcoma, fibroma, and cavernous angioma have been observed in the spleen. Secondary carcinoma and sarcoma are more common. The benign solid tumors of the spleen are exceedingly rare, and practically never give rise to symptoms calling for surgical intervention.

Sarcoma, according to Moynihan, may arise from the capsule or trabeculæ when it is of the fibrous or *spindle-cell type ;* from the lymphoid tissue, *lymphosarcoma ;* or from the endothelium, *endothelioma.* In the first form the growth is slow, in the others rapid. About one dozen such cases have been treated by splenectomy with two or three permanent recoveries.

Cysts of the Spleen.—These are divided into two classes, the parasitic and the non-parasitic cysts. Echinococcus cysts of the spleen are the ones most frequently observed. The cysts are always unilocular, and according to Moynihan may arise from any part of the organ, but are generally located in the upper pole. The non-parasitic cysts, according to Powers, are generally due to trauma, giving rise to parenchymatous or subcapsular hæmatomata. They may reach a large size and occasion symptoms of more or less importance. Generally there is a sense of weight or dragging in the left hypochondriac region. Occasionally there is acute pain or vomiting from pressure on the stomach or intestines. The signs are those of a globular elastic tumor in the upper left quadrant of the abdomen.

The most approved and successful treatment is by splenectomy, although cures by drainage and marsupialization have been reported.

Splenectomy in the non-parasitic cysts may be rendered difficult by the presence of adhesions.

Hypertrophy of the Spleen.

The spleen may be enlarged from simple hypertrophy, Banti's disease, from malarial fever, acute infectious diseases, especially typhoid, from cirrhosis of the liver and other forms of portal obstruction, from leukæmia, Hodgkin's disease, syphilis, tuberculosis, and rickets.

Simple enlargement without other pathologic change occurs in rare instances. The condition produces discomfort from its weight. In Banti's disease there is enlargement of the spleen, a progressive anæmia, hemorrhages into the stomach and intestines, evidenced by profuse hæmatemesis and melena, and, finally, cirrhosis of the liver. The disease occurs in young adults, and generally is fatal in from two to ten years. In malaria the spleen is occasionally enlarged to an enormous extent. Like simple hypertrophy it produces discomfort by its weight and pressure on other organs.

A hypertrophied spleen can be felt projecting downward and inward from beneath the left costal border. As it grows, the direction of its anterior border is toward the umbilicus. It can be recognized by its shape, by the frequent occurrence of one or more notches in its anterior margin, and by the fact that almost invariably it lies just beneath the abdominal wall, the colon and small intestine lying beneath the tumor.

Treatment.—The treatment of simple splenic hypertrophy and that due to malaria, when uninfluenced by medical treatment, is by splenectomy when the size of the organ is such as to cause great discomfort. The results of the operation in these cases is satisfactory, the death-rate being low and the effect on the body metabolism not serious. In Banti's disease there is reason to believe that early removal of the spleen may prevent the later development of jaundice and ascites, the terminal symptoms due to fibrous changes in the liver. Sufficient data are not available to enable one to make a positive statement as to the lasting result of this procedure, but as it is the only treatment which holds out any hope in these cases, it is to be recommended.

Splenectomy.

The abdominal cavity should be opened by an incision over the tumor. If the spleen occupies its normal position, the incision is conveniently made through the upper part of the left rectus muscle near its outer border. The spleen should then be delivered through the abdominal wound, its pedicle clamped, and the organ removed. The vessels of the pedicle should then be separately ligated with strong chromicized catgut and the pedicle returned to the peritoneal cavity. It should be remembered that the pedicle contains the tail of the pancreas, and this should be included in a ligature to avoid leakage of pancreatic fluid. As the pancreatic tissue is exceedingly friable, the ligature should not be drawn too tight, as it would be likely to cut through.

CHAPTER XX.

DISEASES AND INJURIES OF THE KIDNEYS AND URETERS.

Congenital Abnormalities of the Kidney.

Congenital abnormalities of the kidney which are of surgical importance are, variations in position, number, and form.

The position of the kidney may be anywhere from its normal habitat in the upper loin to the floor of the pelvis. Kidneys occupying a position in the iliac fossa or pelvis are extremely rare, may be misformed, and are not infrequently mistaken for pelvic growths.

While the presence of small supernumerary kidneys are of little or no surgical importance, the occurrence of a single kidney only in an individual who is the subject of a surgical disease of that organ is of the greatest moment.

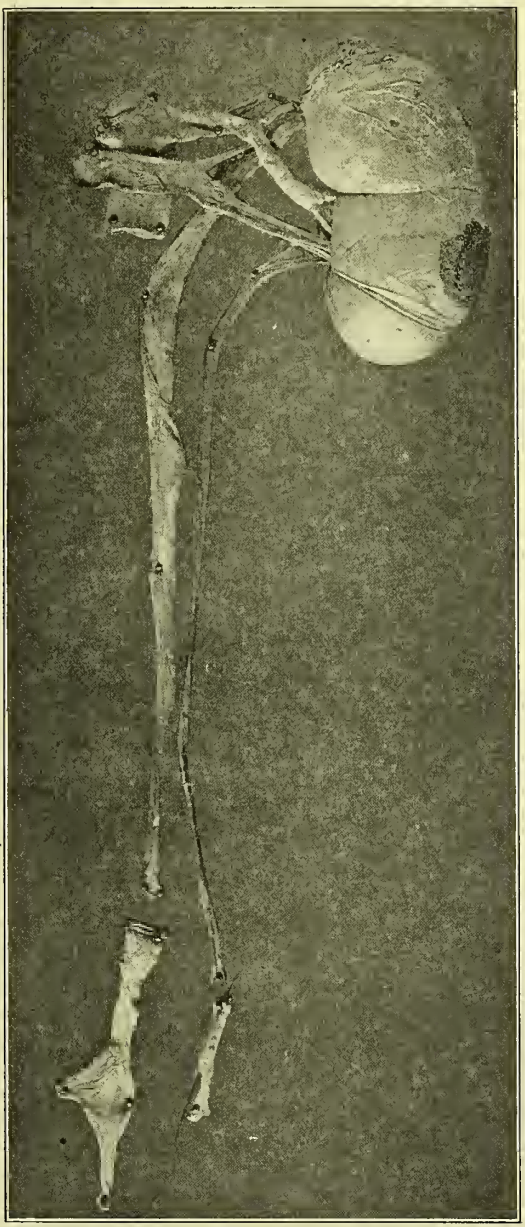
The occurrence of a single large kidney in its normal position, with absence or complete atrophy of its fellow, may be expected once in every 2500 individuals, the actual number reported by Morris in 15,904 autopsies being 6.

The occurrence of a single renal mass formed by a fusion of both kidneys is more common, occurring about once in 1000 subjects. When this is present, the mass usually occupies a position in front of the spine near the bifurcation of the aorta, and is of horse-shoe shape. Very rarely the fused mass may be found in the loin on the right or left side of the vertebral column. The fused kidneys may be united by a bridge of kidney parenchyma, or only by a thin fibrous band. They usually have two sets of vessels and two ureters.

The presence of a double renal pelvis and ureter in a kidney otherwise normal is of comparatively frequent occurrence, and may be of surgical importance, especially in interpreting the results of cystoscopic examination. The writer found this condition 3 times in an examination of 150 subjects in the dissecting-room of the College of Physicians and Surgeons of New York. Fig. 235 represents such a condition where the upper pelvis and ureter were the seat of a tuberculous process, while the lower remained free.

Variations in the blood-supply of the kidney are frequent. The author found in an examination of 150 subjects a double renal artery 70 times; three arteries, 12 times; four, twice; and five,

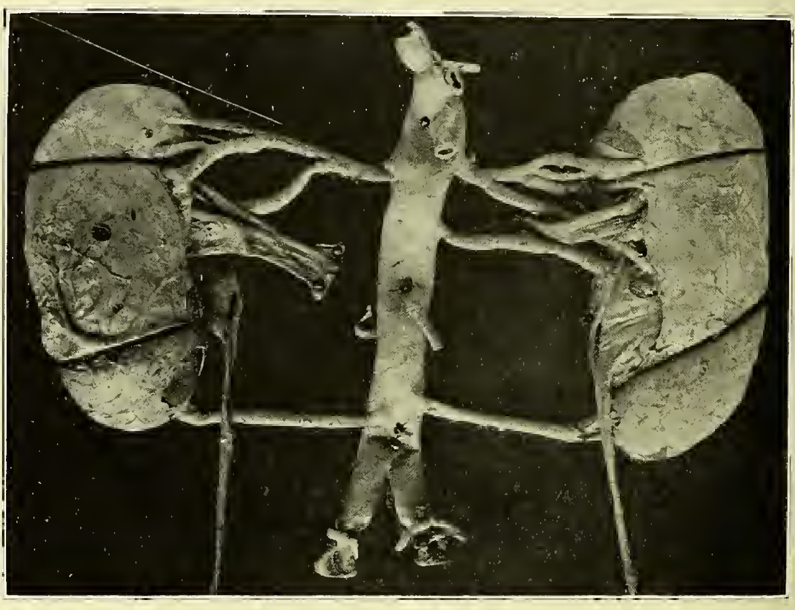
FIG. 235.



Double renal pelvis and ureter. Tuberculosis of upper pelvis and ureter.

once. Of the latter, three branches came from the aorta, one from the common iliac, and one from the ovarian. Important arterial branches to the upper and lower pole of the kidney and to the anterior surface of the organ were found 28 times (Fig. 236). These vascular bands passing to the lower pole of a kidney not infrequently give rise to intermittent hydronephrosis by pressure on the ureter, when the organ is fixed, or by kinking of the ureter, when the kidney becomes movable.

Fig. 236.



Anomalies of renal artery.

Injuries of the Kidney.

Although one of the best protected organs of the body, the kidney is not infrequently injured by falls, blows, crushes, severe muscular strain, gunshot and stab wounds. These injuries are naturally divided into two classes, those which occur without an external parietal wound leading to the injured organ, and those accompanied by such a wound. The former are spoken of as *subparietal* injuries, the latter as *open wounds.*

Like simple fractures, the subparietal injuries generally escape infection from without; and although the injuries are often serious and require grave surgical procedure for their relief, a complicating infection generally can be avoided; while in the open injuries infection has generally taken place before the patient is seen by the surgeon. The possibility of injuries to the kidney by severe muscular effort must be admitted, for cases have been recorded in which lumbar pain, collapse, and hæmaturia have followed a sudden violent muscular strain, but by far the largest number of such injuries are caused by crushes, falls, or blows in the lumbar region.

Subparietal injuries of the kidney may be conveniently divided into three grades: (1) simple contusion with or without injury to the capsule and subcapsular hemorrhage; (2) incomplete rupture, in which the parenchyma is fractured, but without opening of the pelvis; and (3) complete rupture, in which the entire organ is torn across, freely opening the pelvic cavity.

In simple contusion there is often a laceration of the fatty capsule with a very moderate amount of hemorrhage. One or more fissures of the fibrous capsule may occur with ecchymoses, and occasionally a large area of the fibrous capsule is raised by the presence of extravasated blood. In ruptures of the parenchyma the line of fissure generally corresponds with the direction of the bloodvessels. When limited to the cortex, the hemorrhage is moderate; but when complete rupture occurs and the large vessels are torn, the hemorrhage is profuse, often forming an enormous retroperitoneal hæmatoma or intraperitoneal extravasation if that membrane is lacerated by the original injury or ruptured by the pressure of the extravasated blood. When the pelvis or ureter is injured, urinary extravasation necessarily occurs, giving rise to a constantly increasing tumor in the flank, and not infrequently furnishing a source of infection. It occasionally happens that, as a result of a trauma, the kidney escapes damage, the only injury being rupture of one of the vessels of the pedicle, generally a vein.

Symptoms.—These vary with the extent of the injury. In simple contusion there may be only the history of a blow or fall, a slight soreness about the loin, and the passage of urine tinged with blood. In severe cases the pain is more marked, and may be of paroxysmal character, radiating downward along the course of the ureter and into the testicle, this presumably due to the passage of blood-clots along the ureter. If there has been a considerable extravasation of blood in the perirenal tissues, a tumor may be felt, and possibly fluctuation. The hæmatoma may be marked and persist for many days; occasionally the blood collects in the bladder so rapidly that an enormous clot is formed distending that organ and giving rise to retention. There is moderate shock, evidenced by pallor, a rapid, feeble pulse, cold extremities, and occasionally nausea and vomiting. Later, suppuration may occur, forming a more or less extensive retroperitoneal abscess, the symptoms of which are general malaise, local throbbing pain, fever, chills, and wasting. In the severest forms shock is the prominent symptom. This is due to hemorrhage either extraperitoneal or intraperitoneal, and not infrequently to injury to other organs caused by the same trauma. The presence of a tumor in the loin or marked local tenderness with hæmaturia furnishes the surgeon with sufficient data on which to base a diagnosis, although the patient may be unable to describe the accident or his sensations. These cases are often rapidly fatal from shock due to hemorrhage or the effects of concurrent injuries.

A group of persistent symptoms has been described as occasionally following the mildest contusions, which merit special attention. These are paroxysmal pain, fever, hæmaturia, and frequent micturition, occurring weeks or months after such an injury, and strongly suggesting the presence of renal calculus. Exploration reveals in these cases extensive subcapsular hæmatomata, but nothing else. The symptoms are completely relieved by removal of the lesion. In such a case observed by the writer at the Roosevelt Hospital an *x*-ray photograph showed a faint shadow in the region of the blood-clot, which still further obscured the diagnosis.

Prognosis.—As in the case of all visceral injuries, the prognosis should be guarded. The mild cases recover almost without exception, and even the cases with extensive hæmatomata result favorably if infection is avoided.

Where urinary infiltration complicates the injury the prognosis is more grave, and where these and the severer forms of injury cannot receive prompt surgical assistance the outlook is bad.

It is a well-recognized fact that injury to an organ, particularly the kidney, will so affect its nutrition as to diminish its normal resistance to septic infection. The frequent occurrence of septic infarcts or an ascending infection in a previously injured kidney has been noted by all clinical observers.

Treatment.—Except in the mildest contusions, all cases of injury to the kidney should be immediately explored, for the reason that the early symptoms often give no adequate idea of the extent of the injury. Unless there are evidences of intraperitoneal injury the exploration should be by the lumbar route. This exposure of the kidney and retroperitoneal space will enable the surgeon to estimate correctly the extent of the injury, arrest the hemorrhage, remove the clot and extravasated urine, and provide adequate drainage. The treatment of the injured organ must be determined by the extent of the trauma. If the kidney is simply torn apart, often it may be saved by careful approximation of the divided portion even if the cavity of the pelvis is invaded, for the great vascularity of the organ favors rapid repair.

The placing of a few catgut sutures through the capsule, or even through the kidney itself, will be sufficient to insure continued approximation until repair has taken place. Whenever the pelvis is opened and hemorrhage is free, it is wise before closing the rent to insure patency of the ureter by the passage of an ureteral catheter to the bladder.

Whenever urinary extravasation has occurred, the wound should be left partly open and generously drained with gauze or rubber tubes.

In the severe forms, in which the kidney is not only torn, but also crushed and large areas of the parenchyma destroyed, and in cases in which the blood-supply has been seriously compromised or in which the pelvis or ureter has been injured beyond repair, nephrectomy should be practised. Nephrectomy is occasionally advisable also in cases of severe shock accompanied by grave hemorrhage, in which prolonged attempts at repair would not be tolerated.

Prompt healing may be expected in those cases which recover from the immediate shock of the injury and operation, if infection can be prevented. Where infection occurs, however, the suppurating area is apt to be large and the resulting toxæmia great, seriously interfering with repair, and often exhausting the patient's vital forces before recovery can take place. In these cases secondary nephrectomy is often necessary to save life, and should not be too long delayed.

Open wounds of the kidney in the great majority of cases are gunshot or stab injuries, although crushes may result in compound fractures of the lower ribs, and severe railway accidents, machinery injuries, and the flying débris from explosions may cause them. Abbe has reported a case in which the pole of a truck penetrated the thorax, lacerating the lung, liver, and kidney.

In these instances, in addition to the other dangers we have the added risk of infection, as bits of clothing and other infected matters are practically always present in the wound, a circumstance which should lead the surgeon to an immediate exploration in every instance in which the patient's condition justifies the administration of an anæsthetic. After the wounded area is freely exposed and disinfected the same principles should be carried out in the treatment of the injured organ as in cases of subparietal injury.

In gunshot and stab injuries when the direction of the wound leads one to infer that the peritoneal cavity may be injured, it is advisable to perform an immediate exploratory laparotomy, even in the absence of symptoms of intra-abdominal lesion.

Aneurism of the Renal Artery.

True spontaneous aneurism of the renal artery is exceedingly rare.

True or false aneurism arising as a result of trauma is of more frequent occurrence, but is seldom recognized. True traumatic aneurism, or one in which the walls are formed by one or more coats of the artery, rarely reach a large size without rupture.

When such an aneurism ruptures, or when as a result of injury a healthy arterial trunk is ruptured, a false aneurism may result, the walls of which may be formed by the fibrous capsule of the kidney, the distended pelvic cavity, the parenchyma of the organ, or the surrounding areolar tissue. This aneurism may enlarge slowly or rapidly, and may eventually form a tumor large enough to fill half the abdominal cavity.

These aneurisms are of interest to the surgeon for the reason that they constitute one of the later complications of a kidney trauma, and also for the reason that they are often extremely difficult to diagnosticate, owing to the frequent absence of the classic signs of aneurism, pulsation, thrill, and bruit. They are important for the reason that they tend to an invariable fatal termination unless relieved by surgical operation.

The chief **symptoms** are tumor and hæmaturia. The tumor may develop rapidly or slowly according to the size of the ruptured vessel or the resistance of the surrounding tissue. It is not, as a rule, movable, and is rarely tender. Hæmaturia is present in the majority of cases, and may be continuous or intermittent.

The persistence of hæmaturia after an injury and the occurrence of a progressively increasing tumor in the flank without other symptoms should suggest the possibility of false aneurism.

The **treatment** should be nephrectomy and complete removal of the sac. This in large tumors is accompanied by grave danger of hemorrhage and shock. It should be accomplished through a large incision or by the combined lumbar and abdominal route, the advantage of the abdominal opening being to secure more easily the vessels of the pedicle.

Movable Kidney.

Slight vertical mobility of the kidney is present normally, but this cannot, as a rule, be appreciated by palpation except in cases of marked emaciation or abnormal laxity of the abdominal wall.

The kidney is held in position by its vascular connections with the aorta and vena cava; by the so-called perinephric fascia, which is simply a separation into two layers of the posterior portion of the transversalis or deep fascia of the abdomen, which invests the kidney and its fatty envelope in a kind of secondary capsule; by the perirenal fat; by its anterior peritoneal adhesions, and by pressure of other abdominal organs.

The causes which are mostly responsible for abnormal mobility of this organ are: wasting diseases, causing absorption of the perirenal fat; frequent pregnancies, the removal of large tumors or collections of ascitic fluids, causing laxity of the abdominal walls; ptosis of other organs; congenital or acquired relaxation of the peritoneal and fascial connections, and, rarely, trauma. In the majority of instances movable kidney occurs in tall, long-waisted, thin women. Becker and Lenhoff observed this so frequently that they were able to predict, from the general appearance and certain measurements of a patient, whether or not the kidney could be palpated.[1] M. L. Harris believes that in this type of individual, contraction of the space immediately below the diaphragm, by straining, coughing, or body movements, causes pressure upon the upper pole of the kidney, and thus forces it downward.

The frequency of movable kidney is variously estimated to be from 4 to 40 per cent. of all individuals. Eight-tenths of the cases occur in women. The writer found it present to a pathologic degree in 11 of a series of 200 living subjects examined without reference to symptoms, and in 14 of 150 subjects examined in the dissecting-room of the College of Physicians and Surgeons the kidney was found to be freely movable or out of its normal position.

The association of movable kidney with general enteroptosis is occasionally seen, and presents, as a rule, a fairly typical clinical picture; but this association, said by Glénard to be constant, has not been found so frequently by subsequent observers.

The method of determining the presence of a movable kidney is to place the patient in the dorsal position on a hard mattress or table. The abdominal muscles should be relaxed by drawing up the legs. One hand of the examiner should be placed in the costovertebral angle, the other flatly laid over the rectus muscle near its attachment to the costal cartilages. By gently approximating the two hands and instructing the patient to take a deep inspiration, the kidney if abnormally movable can be easily felt by the hand of the examiner except in cases of great obesity or muscular rigidity.

It is convenient to describe three degrees of mobility. A kidney is said to be *palpable* when the lower pole can be felt by the examiner during deep inspiration; *movable*, when the entire kidney can be palpated; and *floating*, when it can be grasped and moved about by the hand or makes extensive excursions to the pelvis or other portions of the abdominal cavity.

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[1] The *index of the body form* was obtained by dividing the distance from the suprasternal notch to the symphysis pubis, by the least circumference of the abdomen, and multiplying it by 100. If the result was above 77 the kidney could generally be palpated; if below 75, it could not.

Symptoms.—In the majority of instances no symptoms accompany this condition, the discovery of a movable kidney being made by accident or during the course of a systematic abdominal examination. In a fair proportion of cases, however, symptoms are produced which vary from a slight occasional discomfort or dragging sensation in the loin to the most severe paroxysms of pain, vomiting, and prostration, requiring for relief the hypodermic use of morphine, or even general anæsthesia.

Symptoms characteristic of this condition may be referred to the urinary or the digestive organs, or to the nervous system. Pain in the region of the affected kidney may be constant, of a dragging, aching character; or it may be paroxysmal, severe, radiating down the course of the ureter to the groin, simulating the colic due to renal calculus. Not infrequently it is accompanied by vomiting and prostration. The association of these symptoms constitutes the renal crises, which are attributed to torsion of the vessels causing sudden hyperæmia, or to kinking of the ureter giving rise to a temporary hydronephrosis.

The digestive symptoms are those of an associated gastroptosis; the nervous phenomena are those characteristic of neurasthenia or hysteria. In women the neurasthenic symptoms are often referred to the pelvic organs.

Prognosis.—Relief to the purely local renal symptoms may be looked for if the condition can be corrected by apparatus or operation. If the symptoms, however, are largely those of neurasthenia, malnutrition, or indefinite disorders of digestion, with vague pains in the abdomen or pelvis, the prognosis should be guarded. The writer has observed that in a large proportion of the neurotic cases operation has proved of no value, and in not a few the condition has been aggravated by the addition of a traumatic neurasthenia.

Treatment.—In cases in which the mobility of the kidney is apparently due to absorption of the perirenal fat, the rest-cure, with a generous diet made up largely of the carbohydrates, will often be of value. If this method is followed, absolute rest in bed must be insisted upon for at least six weeks. The use of pads and abdominal binders may be tried, but there is little reason to suppose that they accomplish much in these cases. The best method is to apply even compression over the entire abdomen by means of an elastic, tightly fitting corset, as advised by Israel. Gallant obtains satisfactory results by the use of the modern, straight front corset applied in the morning before leaving bed. The corset should be two sizes smaller than usual, and should be snugly applied with the patient on the back, the hips being elevated.

In the great majority of cases, however, nephrorrhaphy is the method of choice, and should be advised in all instances when the severity of the symptoms and the condition of the patient justify operation.

INFLAMMATORY DISEASES OF THE KIDNEY.

Renal Suppuration.

Renal suppuration may arise from infection conveyed to the organ directly by a penetrating wound, by extension from a neighboring focus, by an ascending process from the lower urinary passages, or by the blood current.

The first two methods are exceedingly rare; the last two of frequent occurrence. Considerable difference of opinion has existed among surgeons regarding the comparative frequency of ascending and blood infections of the kidney, and while all agree that ascending affections are of frequent occurrence, the majority of the grave suppurating lesions of the organ are undoubtedly of hæmatogenous origin. As both methods of infection may give rise to practically the same clinical types of diseases, a brief description of each may be in order before taking up the individual diseases.

Ascending infections are favored by any interference with the normal outflow of urine from the bladder; they are also favored by any factor which results in a diminished resistance on the part of the individual. Albarran has shown that cultures of the most virulent micro-organisms may, with impunity, be injected into the bladders of dogs as long as there is no obstruction to the normal outflow of urine, but that a fatal pyelonephritis results if an artificial retention is produced by ligation of the urethra. It is likewise well known that in the aged and in those whose resistance has been greatly diminished by dissipation and disease, involvement of the kidneys is far more frequent from the extension upward of an infection of the bladder or urethra than in young subjects and those who enjoy robust health.

The commonest type of the ascending infection is that observed in the aged victims of chronic retention from urethral strictures or prostatic enlargement. In these individuals the chronic retention has already produced dilatation of the bladder and ureters, and a diminished resistance of the renal parenchyma from prolonged pressure. Infection, introduced often by the first passage of a catheter, results in an active cystitis, which is soon followed by an extension of the inflammation along the mucous membrane of the ureters to the renal pelvis, where it rapidly ascends the straight tubules, and results in multiple foci of infection in the cortex and acute degeneration of the epithelium of the tubules and glomeruli. This not infrequently causes a complete suspension of the renal function, with death from a combination of uræmia and sepsis. In certain rare instances the ureteral mucous membrane apparently takes no part in the process, the infection reaching the kidney by means of the peri-ureteral lymphatics.

The presence of a ureteral calculus or new growth, of a tuberculous area of the trigone, or any other factor which interferes with the normal sphincteric action of the lower end of one ureter, will act as a predisposing cause of unilateral renal infection.

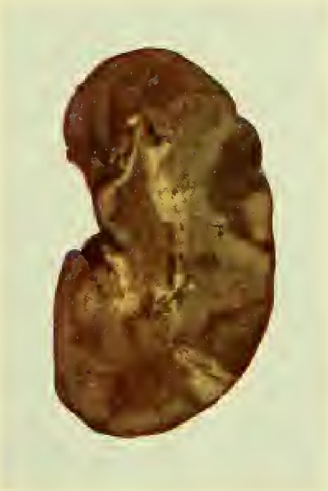
In the milder types of ascending infection the process may be arrested at any point. The terminal condition, therefore, may be pyelitis, pyelonephritis, pyonephrosis, cortical abscess, or perinephritis.

Hæmatogenous infections of the kidney are invariably produced by pathogenic micro-organisms conveyed to the organ by the blood current. It is a well-known and generally accepted fact that during the progress of any acute infectious or septic disease, certain micro-organisms, giving rise to the symptoms, find their way into the blood current, and are either destroyed by the bactericidal action of the blood itself, or by substances encountered in the passage of the blood through certain organs, or they are excreted through the kidneys. Pernice and Scaglioni, in Virchow's *Archiv.*, 1894, give the results of an elaborate series of experiments, showing the anatomic changes occurring in the kidney by the excretion of various pathogenic and non-pathogenic bacteria.

Albarran, in 1889, reviewed the entire subject of renal infection, and concluded that pathogenic bacteria may, under certain conditions, be eliminated through the kidneys without producing marked anatomic lesions; their elimination, on the other hand, may give rise to a bacteriuria, to a glomerular nephritis with degeneration of the epithelium, to multiple non-pyogenic infarcts, to pyogenic infarcts or multiple abscesses, to perinephritic abscess, to pyelonephritis, or to a rapidly fatal toxæmia. He also stated that the effects of trauma, excessive functional activity, the presence of toxic products, and renal retention, all served to accentuate the process and to favor the formation of graver lesions.

The lesions most commonly found in these cases are due to a plugging of the smaller arteries and capillary vessels with groups of organisms. These minute emboli are later surrounded by a zone of round-cell infiltration. Where the larger trunks are thus involved, triangular infarcts are produced; where the capillaries only are involved, minute abscesses are seen throughout the cortex

PLATE XII



Acute Septic Infarcts of Kidney.

Colored photograph of specimen in author's collection.
(Lumiere process.)

and beneath the capsule. If the process progresses, the bacterial emboli are rarely recognized; only areas of necrosis or purulent infiltration are apparent.

At a still later stage many of these collections of pus coalesce, forming larger parenchymatous abscesses, which may rupture through the capsule, giving rise to perinephritis, or into the pelvis, giving the typical picture of pyelonephritis.

It will thus be seen that both the ascending and the blood infections may give rise to lesions which, on gross inspection, appear identical, and each may result in the various degrees and types of the commonly observed renal inflammations.

Acute Unilateral Hæmatogenous Infection of the Kidney.—In the preceding paragraphs the pathologic process occurring in blood infections of the kidney was described. While most surgeons of experience appreciate the relationship between this and the easily recognized advanced types of renal suppuration, three important facts regarding the behavior of this variety of infection are not generally appreciated by the profession. The first is that the lesions are often unilateral; the second, that in the severest type of the affection the toxæmia is so overwhelming that death often occurs before any characteristic renal symptoms are developed; and the third is that these cases, in their early symptomatology, vary greatly, the clinical picture often suggesting an acute grip, lobar pneumonia, appendicitis, or cholecystitis.

These facts would warrant a separate consideration of the acute stage of this type of infection, which, by its symptom complex, deserves recognition as a distinct pathologic entity. Two factors are necessary for the production of this type of renal lesion: (1) A septic focus somewhere in the body capable of furnishing a certain number of pathogenic bacteria to the blood current; and (2) a diminished resistance on the part of one kidney due to trauma, the presence of a calculus, an obstructed ureter, or a previous septic lesion. The disease, therefore, not infrequently follows pneumonia, tonsillitis, any of the exanthemata, typhoid fever, a furuncle, or possibly obstinate constipation, as the colon bacillus is often the offending organism.

Over 80 per cent. of the cases are observed in women, and in a large majority of instances the right kidney is the one affected.

In the severest cases the perirenal fat and areolar tissue are œdematous, the kidney moderately enlarged and deeply congested. The surface is studded with deep red, elevated areas or groups of miliary abscesses.

On section one or more triangular infarcts may be seen with numerous necrotic areas and suppurative foci. There is marked cloudy swelling of the cortex (Fig. 237).

The organisms most frequently obtained by culture from these lesions are the colon bacillus, bacillus typhosus, streptococcus pyogenes, and staphylococcus aureus. The author has been able to reproduce these lesions in animals by all of the above-mentioned organisms, and also by the pneumococcus and bacillus pyocyaneus.

Diagnosis.—The disease may or may not be ushered in by a chill. When present it generally indicates a severe type of infection. The initial rise of temperature is high, generally 104° or 105° F.; the pulse is frequently 120 or more. The toxæmia is marked from the first and, with the high fever, suggests often an acute grip, lobar pneumonia, or one of the exanthemata. Then follows a more or less vague pain in the abdomen or flank corresponding to the side of the lesion. Tenderness and muscular rigidity over the region of the appendix or gall-bladder leads often to error in believing one of these organs to be the seat of disease. As the urinary secretion from the infected kidney is greatly diminished and is largely diluted by the abundant secretion from the unaffected organ, the mixed urine, when passed or drawn from the bladder, is often quite normal in appearance, and the slight trace of albumin, blood, and pus is often overlooked unless a more than ordinarily careful examination is made. The one pathognomonic sign present in all cases is a marked unilateral costovertebral tenderness.

Prognosis.—In regard to prognosis it may be stated that in the severe cases death almost invariably occurs unless the symptoms are promptly arrested by nephrectomy. Many of the less severe cases, if untreated, go on to the development of the gross suppurative lesions to be considered in the next section, while many of the mildest type recover spontaneously.

Treatment.—In regard to treatment, the cases should be divided into three classes:

The severe type, in which the temperature remains high and the toxæmia is rapidly progressive. These cases require nephrectomy at the earliest possible moment. The milder cases are those in which the initial temperature may be high, but begins to fall within forty-eight hours, and where the toxæmia is less marked. These cases often may be successfully treated by decapsulation, which relieves the intense congestion and allows nature to complete the reparative process. Where one or more cortical abscesses are present, they should be opened and drained.

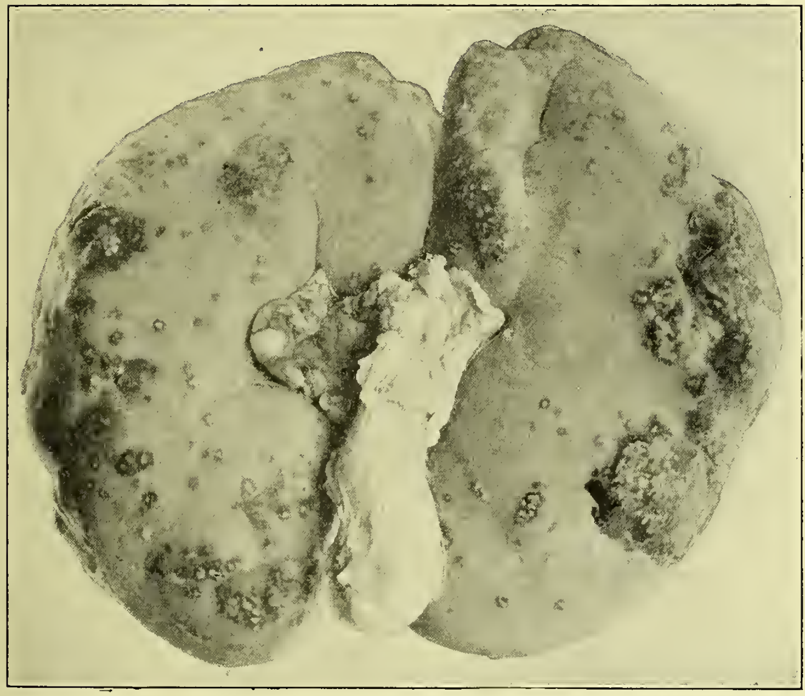
In the mildest type the case may be treated expectantly with a reasonable prospect of complete recovery, although the writer has observed two or three patients in which a chronic pyelonephritis has remained.

Pyelitis.

Pyelitis is an inflammation of the pelvis of the kidney and ureter, caused by infection from the rupture of a septic focus in the kidney-substance, or from an extension upward of infection from the bladder and lower urinary passages. The author never has been convinced that suppurative pyelitis ever arises spontaneously, or that a blood infection of the renal pelvis ever occurs without lesions in the kidney substance.

In the majority of cases pyelitis is accompanied by nephritis, and to this condition the term *pyelonephritis* should be applied.

Fig. 237.



Acute septic infarcts of kidney. (Blake.)

Morris has described a form of non-suppurative pyelonephritis, in which the lesion of the renal parenchyma consists in an acute toxic but non-suppurative interstitial inflammation. This is present in a fair proportion of the cases of pyelitis, and may seriously compromise the renal function. By far the greater number of these cases arise from infection from below, due to contamination of the bladder through the introduction of instruments or to extension upward of a gonorrhœal urethritis. In these instances the disease is frequently bilateral. Conditions which favor kidney infection in this manner are: back pressure of urine from obstructive disease of the prostate or urethra, mobility of the kidney, and the presence of calculus.

Symptoms.—In uncomplicated pyelitis the symptoms are: fever, lumbar pain, vesical irritability, and, occasionally, a diminished secretion of urine containing albumin, casts, pus, and blood. Suppression of urine, delirium, and stupor may follow if the kidney parenchyma is extensively involved, and the attack end fatally in a few days. In the milder cases the patient may live through the acute stage and pass into one of chronic pyelonephritis, in which the only evidence of disease may be the presence of albumin and pus in the urine. This condition may be present for years, the patients apparently enjoying fair health, but a recurrence of the acute symptoms may be expected to follow renewed irritation of the lower urinary passages, the abuse of alcohol, or the administration of an anæsthetic. In the milder cases, especially if of gonorrhœal origin, complete recovery may take place.

The **treatment** should consist of rest in bed, diuretics, and the internal administration of urotropin in doses of from 5 to 15 grains two or three times a day, taken in large quantities of water. The symptoms of uræmia must be controlled by free catharsis and diaphoresis, those of sepsis by heart tonics and supporting measures. The use of prolonged rectal irrigation with normal salt solution, or intravenous infusions of the same agent, are often followed by the most satisfactory results, both on the circulation and the function of the kidneys.

Suppurative Pyelonephritis.

In this disease the infection is a pyogenic one, and results in the formation of multiple foci of suppuration in the parenchyma of the kidney. These may coalesce and form one or more large abscesses, or the entire organ may be honeycombed with suppurating areas. As in the non-suppurative form of the disease, the infection may reach the kidney by an upward extension from the lower urinary passages, or it may be the result of infection conveyed to the organ by the blood from some distant focus. In either event the disease is generally bilateral. Alexander Johnson has, however, recently called attention to the fact that the affection is often unilateral; or, if not strictly limited to one side, that the chief destructive lesion is frequently located in one kidney; and that the impaired functional activity of the other may be largely due to the coexisting toxæmia.

The **symptoms** of this condition are practically the same as in the non-suppurative form of the disease, with the addition of a more marked pyuria, leucocytosis, and the presence often of a tender kidney tumor.

Abscess of the Kidney.

Abscess of the kidney-substance may occur independently or in connection with suppurative pyelonephritis. It may be caused by the coalescence of several small foci of suppuration, may arise from a septic embolus, or from the infection of a single blood-clot or mass of damaged tissue due to trauma. As in the former condition, the infection reaches the organ through the blood or from the lower urinary organs. The association of abscess of the kidney and calculus has been frequently noted. One or both kidneys may be involved. One abscess only may be present, or several may occur in the same kidney. As the disease advances the normal tissue of the kidney is destroyed, and if the progress is not arrested this leads to an opening either into the renal pelvis or through the capsule into the perirenal tissues. In the former event the disease may be cured spontaneously, in the latter a perinephritic suppuration results.

The course of the disease may be acute or subacute; in the acute forms the clinical picture is one of acute progressive sepsis accompanied by pain in the affected side and a diminished secretion of urine. The urine may be albuminous, but contains no appreciable quantity of pus unless the abscess ruptures into the pelvis. There is a marked leucocytosis, and hæmaturia may be present. Examination may reveal the presence of a renal tumor, but this is not common. Tenderness is generally present and often muscular rigidity. If the condition is accompanied by perinephritis, there are œdema and induration in the flank, and later fluctuation may be detected.

In the subacute cases the symptoms may be misleading, the condition being diagnosticated typhoid fever or malaria. This mistake, however, should never occur if a blood examination can be made.

In the severe cases, if unrelieved by surgical means or by spontaneous rupture, death may be expected from sepsis within two or three weeks. The spontaneous evacuation of the pus into the pelvis, ureter, or intestine, may result in a sudden and complete disappearance of the symptoms, and recovery may follow without further treatment.

Pyonephrosis.

This condition may represent the terminal stage of any acute suppurative process in the kidney. It is generally unilateral and consists in a dilatation of the renal pelvis with pus from plugging of the ureter with a calculus, a bit of fibrin, or clot of blood; or it may result from the infection of a hydronephrosis. In either event the kidney-substance is quickly destroyed both by the pressure of the accumulated fluid and the destructive tendency of the infection.

The **symptoms** are acute pain and tenderness in the flank, with chills, fever, sweats, and general prostration. The urine may be negative; blood examination reveals a marked increase in the leucocytes. On physical examination a tender tumor can generally be found in the lumbar region, which is oval, elastic, and may move slightly with respiration. It is best appreciated by bimanual palpation, and can generally be demonstrated to lie behind the colon.

Treatment of Suppurative Disease of the Kidney.

There is a growing tendency among surgeons to employ more radical measures in the treatment of the suppurative diseases of the kidney. Formerly pyelonephritis was regarded as beyond the reach of surgical relief for the reason that the lesion was supposed always to be bilateral, and the treatment of kidney abscess and pyonephrosis was limited to incision and drainage, postponing to a later period the nephrectomy which was generally found to be necessary. It was held by many that secondary nephrectomy was a far safer operation than immediate removal of the organ. Recent observations, however, have shown that in the majority of instances better results can be obtained by primary nephrectomy in these hopelessly diseased kidneys than by nephrotomy, which rarely results in a cure, and which always leaves behind a focus of infection which may result in a persistent sinus and prevent complete recovery from the sepsis. Nephrotomy is indicated in conditions of grave sepsis in which prolonged operation would be fatal; but in these cases the secondary nephrectomy should be performed as soon as the condition of the patient permits, as adhesions soon form which often render the secondary nephrectomy an exceedingly difficult and dangerous procedure.

When nephrotomy is employed, the kidney should be exposed by a lumber incision, the suppurating cavity opened by an incision through the convex border, the finger introduced, and all septa broken down, allowing free drainage, which should be maintained by the use of a large rubber drainage-tube introduced into the suppurating cavity and surrounded by a snug gauze packing to guard against hemorrhage, which is often severe and controlled with difficulty. In all operations upon cases of acute renal sepsis the surgeon should aim to complete his operation in the shortest time compatable with accurate work, as prolonged anesthesia and exposure on the operating-table may seriously interfere with the function of the remaining kidney, perhaps already compromised by the coexisting toxæmia.

In all such cases it has been the writer's custom to administer an intravenous infusion of from 500 to 1500 cc. of normal salt solution immediately after operation with a view to increasing the activity of the skin and of the remaining kidney.

Perinephritis and Perinephritic Abscess.

Perinephritis or perinephritic abscess is an inflammation of the retroperitoneal connective tissue surrounding the kidney. This may arise from an infection derived from the kidney or bowel, from the blood, or from the lymphatics; or it may result from the introduction of infectious material from without by means of a penetrating wound. It is commonly, therefore, associated with suppuration or trauma of the kidney, ulcer of the large intestine, appendicitis, inflammatory processes in the pelvis, spine, or extremities; or occurs as a metastatic lesion in general sepsis. The process may be limited to the region of the kidney, or may extend upward behind the liver or downward to the region of the pelvic brim or groin. If unrelieved, rupture may take place into the bowel or externally. In one case under observation of the writer the pus burrowed downward through the inguinal canal and infiltrated the subcutaneous cellular tissue, involving nearly one-half of the abdominal wall, and causing extensive necrosis of the external oblique muscle and its aponeurosis.

The **symptoms** are at first pain in the kidney region with fever. If the process is a virulent one, there may be early chills and rapid development of profound sepsis, with increasing pain and tenderness in the affected side. Generally, however, the process is slower, the patient may not feel ill enough to be in bed, and may keep about for a week or longer. In these instances the gait is characteristic, the body is bent forward and toward the affected side, and the thigh is never fully extended in walking. The fever gradually rises, the temperature-curve not infrequently being like that of typhoid fever. As the pain increases, chills develop, followed by sweats and prostration. Examination reveals tenderness, muscular rigidity, induration, and œdema of the flank. Blood examination reveals a high leucocytosis. The urine may be negative or give evidences of nephritis.

The danger in the severe cases is from the early development of a fatal sepsis; in the milder cases, if unrelieved by appropriate surgical measures, from exhaustion and degenerative changes in the other organ. Spontaneous recovery may take place by rupture into the bowel, or possibly in very mild cases by subsidence of the inflammatory process and encapsulation of the small focus of pus.

The **treatment** should be early incision, thorough exploration, and adequate drainage. Occasionally a completely disorganized kidney, large masses of necrotic tissue, or broken-down lymph-nodes may be present, and should be removed. The best incision for this is the oblique lateral one described on page 548. One or more counter-incisions may be necessary to insure adequate drainage.

The toxæmia should be combated by generous diet, stimulants, and tonics.

Syphilis of the Kidney.

Syphilis of the kidney occurs during the secondary and tertiary stages of the disease.

In the early secondary period a temporary albuminuria may be present as in the case of other infectious diseases. This usually yields to mercurial treatment, or it may pass into the form of a chronic interstitial or diffuse nephritis. These chronic forms more often develop during the later stages of the disease, and are not influenced by treatment.

The only syphilitic lesion of surgical importance is the gummatous nephritis with or without interstitial changes. This not infrequently gives rise to a distinct enlargement of the organ, strongly suggesting a new growth or tuberculosis. Symptoms of this condition may be entirely wanting, or there may be lumbar pain, hæmaturia, or vesical irritability. If the gummatous mass softens and ruptures into the pelvis, the urine may give evidences of the disease by the presence of purulent or caseous matter or bits of necrotic tissue. The condition is often mistaken for tuberculosis. In doubtful cases tuberculosis can be positively excluded by the inoculation of a guinea-pig with the urinary sediment.

The **treatment** is purely medical unless the disorganization of the kidney is so advanced as to require nephrectomy, which should be performed whenever it is demonstrated that medical treatment fails to arrest the progress of the disease.

Tuberculosis of the Kidney.

Primary tuberculosis may occur in any part of the genito-urinary tract. In a large proportion of the cases its origin is in the kidney.

It occurs in two forms, the acute miliary and the more chronic caseating varieties. The former is more common in children, and is generally bilateral; the latter occurs more frequently in adults, and often is confined to one side. The infection may reach the kidney by the blood-current, which is common, or by means of an ascending infection from the bladder, which is rare. In the hæmatogenous infections the process is the same as in the hæmatogenous septic infections, and, like the latter, may be limited to one kidney. Where the infection is from the blood-current the lesions appear first in the cortical portion of the kidney as numerous minute distinct miliary tubercles. As the disease progresses these may enlarge and coalesce, forming cavities filled with caseous material, which finally rupture into the calices or pelvis. These structures in turn become diseased, the process extending gradually down the ureter to the bladder. From this point the disease extends in two directions. It may pass upward along the ureter to the opposite kidney, or it may pass outward along the urethra, and in the male involve the prostate, seminal vesicles, and testicle.

If the disease arises primarily in the lower portion of the genito-urinary tract, the mucous membrane of the bladder becomes diseased in the region of the ureteral orifice. From this point the process extends upward along the ureter until the pelvis of the kidney is reached. The apices of the pyramids are next invaded, and the disease extends upward along the straight tubules until the cortical substance is reached. Not infrequently autopsies reveal the presence of both varieties of renal tuberculosis in the same subject, the descending on one side and the ascending on the other: showing conclusively that the disease occurred primarily in one kidney, extended downward to the bladder, then upward along the healthy ureter to the opposite kidney, which was finally invaded,

The fibrous capsule of the kidney generally acts as an effective barrier to extension of the disease. Occasionally, however, it will become involved, and the disease may extend to the perirenal connective tissue, the liver, spleen, or intestine. Obstruction of the ureter by a plug of caseous material, calculus, blood-clot, or by infiltration of its walls, gives rise to hydronephrosis or pyonephrosis.

The course of the disease varies greatly. In some instances, especially of the miliary variety, in which extensive involvement of other organs occurs, the progress is very rapid, and death may occur in a few weeks or months after the first symptom pointing to kidney disease has been noted; in the majority of instances, however, more particularly in the caseating variety, the progress is slower, often with remissions, and under favorable hygienic conditions the disease seems sometimes to be spontaneously arrested.

Symptoms.—In a certain proportion of cases the disease advances to the formation of cavities in the kidney without giving rise to characteristic symptoms. This, however, never occurs in the ascending variety, in which the bladder and ureteral involvement always gives rise to pain, frequency of micturition, pyuria, and occasionally hæmaturia, before the disease reaches the kidney. These symptoms may also be present while the disease is limited to the kidney; in the majority of instances, however, when this organ is invaded primarily or as a result of upward extension of the disease, there may be lumbar pain, which varies in character from a slight sense of weight and discomfort to severe paroxysmal pain suggesting the colic of renal calculus. Polyuria occurs as an early symptom; later the urine becomes cloudy and albuminous. Moderate hæmaturia is present, often as the earliest symptom, and not infrequently the kidney enlarges sufficiently to become a palpable tumor. The uniform shape of this tumor is generally maintained, although it may present an irregular surface owing to unequal involvement of its substance. When obstruction to the ureter takes place the tumor may attain a large size. Tenderness over the region of the kidney is generally present even when the organ is not palpable.

In extensive ureteral involvement, especially in thin subjects, the ureter can occasionally be palpated as a thickened, tender, elongated mass in the lumbar region. Associated with these local symptoms there is generally a progressive impairment of the general health, evidenced by a loss of weight and bodily strength, anorexia, anæmia, and the constant presence of an evening temperature. Later, as the disease progresses, chills, sweats, diarrhœa, and œdema of the extremities may be present.

Diagnosis.—While the symptoms of early tuberculosis of the kidneys may form a sufficiently characteristic group to enable the surgeon to arrive at a correct diagnosis, more often this is not possible, the symptoms pointing more to calculus, new growth, or other varieties of inflammation. In these doubtful cases the diagnosis can be established only by the finding of the tubercle bacilli in the urinary sediment, although a positive tuberculin reaction furnishes strong presumptive evidence in the absence of signs of tuberculosis elsewhere in the body. The urine should be examined fresh, the sediment precipitated by the centrifuge, and at least ten slides thoroughly examined. A negative result does not exclude tuberculosis, as inoculation of a guinea-pig often will give a positive result when the microscopic examination fails.

The question of determining which kidney is the seat of the disease is most important from the point of view of treatment. This can be absolutely settled by catheterization of the ureters and examination of the two specimens of urine thus obtained. Cystoscopy may reveal the presence of a diseased area of mucous membrane around the mouth of the ureter on the affected side, or purulent urine may be seen to come from one ureter while that from the other is clear. Competence of the healthy kidney may be determined by an examination of the separated urines, by the freezing-point of the blood-serum, by the phloridzin or the indigo-carmine test.

Prognosis.—This depends largely upon the stage of the disease. Primary nephrectomy, when the disease is limited to one kidney, can generally be relied upon to cure the patient. Removal of a primary renal focus, even in the presence of secondary bladder involvement, will often be followed by a cure.

Harris has recently reported one cure, and two cases where marked improvement followed removal of one tuberculous kidney, the other being secondarily involved.

Treatment.—If in a presumably healthy individual tuberculous disease can be accurately located in one kidney, the other genito-urinary organs being free, the indication is for nephrectomy at the earliest possible moment. Nephrectomy is advisable also in cases of moderate involvement of the bladder and even other portions of the genito-urinary tract, if it can be ascertained that the lesion in the kidney is the primary one and is chiefly responsible for the patient's symptoms. The removal of a kidney in the presence of advanced disease of the other organs and involvement of the opposite kidney is justifiable as a palliative measure to relieve suffering. Nephrotomy to relieve a tuberculous or mixed pyonephrosis may, very rarely, be indicated when the conditions render nephrectomy inadvisable. The general health should be built up by an abundance of nourishing food, tonics, and the internal administration of iron, arsenic, and cod-liver oil. Residence in a high altitude, preferably surrounded by pines, is of decided advantage, the symptoms disappearing often, as a result of such a change, in a surprisingly short period of time. The use of tuberculin in cases in which the disease cannot be completely removed has been advocated.

RENAL CALCULUS.

Under certain conditions of the body nutrition solid substances which are normally in a state of solution in the urine are precipitated. This precipitation may take place in the kidney or bladder, and when unaccompanied by any other pathologic condition the minute, sand-like masses are washed away by the urine, a condition usually spoken of as *gravel.* If in addition to the presence of the precipitated solid particles we have a minute blood-clot, bit of mucus, or some other albuminoid substance, the particles are often glued together, forming a small concrement, which may pass away with the urine or remain to increase in size, giving rise to more or less disturbance in the function of the organ by its presence alone or by the inflammatory reaction which it begets.

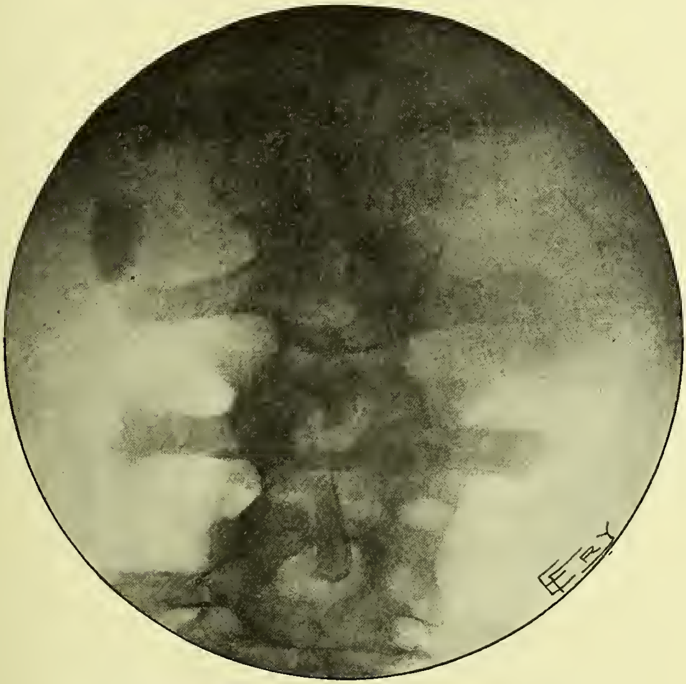
Causes.—Gouty diathesis, sedentary habits, lack of exercise, rich food, alcohol, inflammatory conditions of the urinary organs, and trauma may be enumerated as among the causes of calculus.

Varieties.—Primary renal calculi may be composed of uric acid or the urates, calcium oxalate, phosphate of lime, carbonate of lime, cystin, or xanthine. These may occur without pre-existing inflammation of the pelvic mucous membrane. Secondary calculi are composed of ammonio-magnesium phosphate alone or in combination with other salts, and are generally the result of an inflammatory process in the kidney or pelvis. While primary stone may arise at any age, the calculus of infancy is generally composed of ammonium urate, that of early adult life of uric acid or the urates, that of later life of calcium oxalate.

One or both kidneys may be affected, and the number of concretions in each may vary from one to several hundred. The presence of a calculus in a healthy kidney gives rise at first to a catarrhal exudate made up of mucus and white cells; later, an infection may occur which gives rise to pyelitis, pyelonephritis, or, if obstruction of the ureter develops either from impaction of the stone or from inflammatory stricture, hydronephrosis or pyonephrosis. The process may extend by rupture to the perirenal tissues, causing extensive perinephritic abscess. If both ureters have become obstructed as a result of calculous disease, *calculous anuria* results, which, unless speedily relieved by surgical means, gives rise to fatal uræmia. Other conditions giving rise to calculous anuria are congenital absence of one kidney with calculous obstruction in the single ureter, or complete destruction of one kidney by a tuberculous or septic process, with an obstructing calculus in the opposite organ.

Symptoms.—That renal calculus may exist for a long period of time without giving rise to symptoms referable to the kidney, is abundantly proved by numerous autopsies. In these instances the stone usually occupies a position in the parenchyma of the kidney or is firmly fixed in one of the calices. Movable stone in the pelvis of the kidney almost invariably gives rise to one or more of the following symptoms—*i. e.*, pain, hæmaturia, vesical irritability, and pyuria. The pain may be constant, located in the flank, occasionally radiating downward along the course of the ureter; less frequently it extends upward to the shoulder or chest, and rarely it is referred entirely to other organs, as the testicle, ovary, opposite kidney, or the sole of the foot (Morris). In many cases the pain is paroxysmal, severe in character, extending downward from the flank to the testicle or the urethra. During these attacks the suffering is often extreme, necessitating large doses of morphine or the administration of an anæsthetic for its relief. The point of greatest intensity of the pain may be somewhat below the kidney. Not infrequently it is located at or near McBurney's point on the right side or at a corresponding point on the left. These attacks of renal colic are generally characterized by a sudden onset and by equally sudden relief. They are often, but by no means always, caused by the passage of a stone from the kidney to the bladder. Next to pain, the most characteristic symptom of renal calculus is hæmaturia. The amount of blood lost is exceedingly variable, but, as a rule, it may be said that it is rather more than in renal tuberculosis, and rather less than in tumor of the kidney. The hemorrhage is apt to accompany and follow

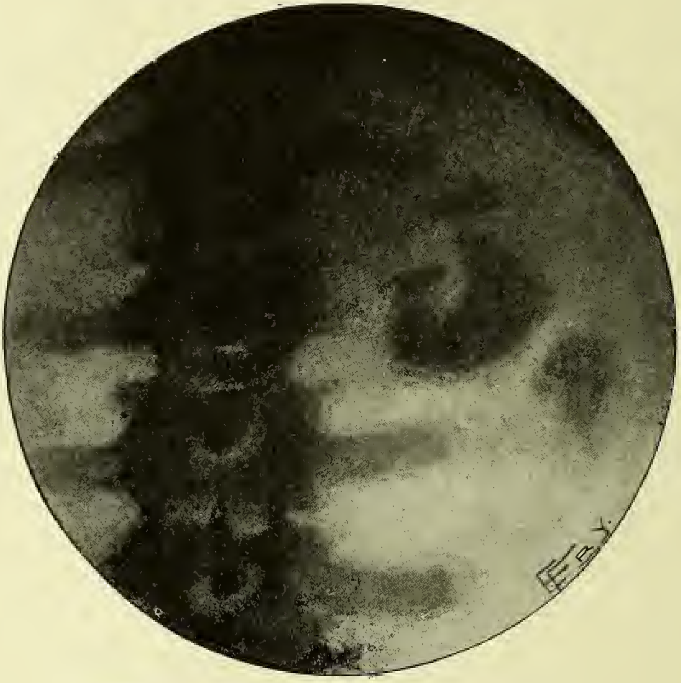
FIG. 238.



Radiogram of renal stone. (From plate by Dr. L. G. Cole.)

attacks of colic, and both are frequently occasioned by exercise or riding. While noticeable hæmaturia is often absent, the microscope is pretty sure to reveal the presence of blood at some period of the disease. In 32 cases of renal or ureteral stone recently reported by the author, hæmaturia was present in 16. In only 7 of these cases, however, was it present in sufficient quantity to color the urine, so that it was recognized by the patient; in 9 it was found only by the microscope. Vesical irritability, evidenced by frequent and painful micturition, is occasionally present, and is often a misleading symptom, directing the attention of the surgeon to the bladder or prostate. Pyuria may occur as a late symptom. The kidney origin of the pus is indicated by the acid reaction of the urine and by the presence of casts and renal epithelia.

FIG. 239.



Radiogram of renal stones. (From plate by Dr. L. G. Cole.)

Nausea, vomiting, prostration, cold sweats, and extreme nervous irritability often accompany the attacks of colic. Fever may be present after infection has occurred. When pyonephrosis or perinephritic abscess is added, there also may be chills, sweats, and other evidences of general sepsis.

Of the physical signs of renal calculus, the only one upon which much reliance can be placed is the presence of a characteristic *x*-ray shadow. Costovertebral tenderness to pressure or percussion is frequently present, and is thought by some authorities to be almost pathognomonic, but in the writer's opinion it is of doubtful value, as it is so often encountered in other pathologic conditions. The occurrence of a renal tumor, while occasionally present in calculous disease due to a plugging of the ureter, is also more characteristic of other conditions.

To be of diagnostic value an *x*-ray plate must show the structure of the vertebral bodies, the transverse processes to their tips, and the outline of the psoas muscle. In addition to this the shadow made by the calculus should have a distinct and well-defined outline. Of the various calculi, those showing the darkest shadows are the phosphatic and the calcium oxylate stones, those showing the faintest shadows are composed of pure uric acid. Mixed stones and those composed of the urates and of cystin give shadows which in distinctness vary between the two extremes (Figs. 238 and 239).

Diagnosis.—As renal calculus may exist without symptoms or signs, and as all the symptoms of this disorder may occur in other pathologic conditions, an absolute diagnosis is often impossible. The association, however, of colic, hæmaturia, and vesical irritability, generally following bodily exercise, riding or jolting, together with the constant presence of tenderness over the corresponding kidney, in the absence of bladder, prostate, or urethral lesion, renal tumor, or the evidences of tuberculosis, would render the diagnosis of renal calculus highly probable. If, in addition to this, the urine collected from the affected side gave evidences of pus, blood, or crystals, while that from the opposite kidney was normal, the probability would be accentuated. The demonstration of a distinct shadow in a radiograph corresponding to the position of the affected kidney would render the diagnosis practically certain. It is rare, however, to encounter cases presenting such an association of symptoms. The constant presence of one or more of these symptoms or signs, if of sufficient severity to interfere with the health and comfort of the individual, if not relieved by hygienic or medical means, would justify an exploratory nephrotomy, and if no stone was found, in all probability some other lesion would be discovered and the patient relieved.

Prognosis.—Although a stone in the kidney may remain symptomless for a long period of time, and apparently occasion no serious mischief, still in the great majority of instances it eventually gives rise to infection and other lesions which lead to destruction of the organ or the life of the individual.

Treatment.—Prophylactic treatment should be instituted in all cases in which a tendency to the formation of stone is evidenced by the passage of gravel. This should consist in regular exercise, the avoidance of rich food and alcohol, and the daily ingestion of large quantities of water. The alkaline diuretics may be employed if there is constant hyperacidity of the urine. The treatment of an attack of renal colic should consist in a hot bath, copious draughts of water, morphine subcutaneously or the inhalation of chloroform. In the presence of symptoms pointing strongly to the presence of renal calculus, the treatment should be early exploratory nephrotomy and removal of the stone if present. The operation is practically without danger if undertaken at an early period, before the renal function has been seriously compromised by infection or extensive destruction of the secreting substance. To delay operation in the hope of causing the stone to disappear as a result of treatment by mineral waters or medicine, is but to invite disaster and to postpone operation to a period when the conditions are far less favorable, as the mortality following nephrotomy for pyonephrosis, and nephrectomy necessitated by complete disorganization of the kidney, renders these operations far more formidable procedures.

The technic of nephrolithotomy, nephrotomy, and nephrectomy is described on page 547.

TUMORS OF THE KIDNEY AND SUPRARENAL GLAND.

Both benign and malignant tumors occur in the kidney. In the older text-books, sarcoma, carcinoma, and adenoma are spoken of as those most frequently observed. Since the classical article by Grawitz, published in 1883, in which he called attention to the frequency of tumors arising from adrenal rests, a great deal of study has been given to these neoplasms, which has resulted in a decided change in nomenclature and an entirely new conception of the pathology of renal growths.

Regarding frequency, Watson states that the pathologic records of the Boston City and Massachusetts General Hospitals for the past ten years show that considerably more than 50 per cent. of all renal tumors encountered could be classed as hypernephromata.

Benign tumors of the kidney are rare. *Papillomata* occur in the pelvis, and grow, as a rule, slowly. Like papillomata of the bladder, they have a strong tendency to degenerate into epitheliomata. *Adenomata* are occasionally encountered arising from the renal parenchyma. They are generally encapsulated, but prone to malignant change. *Angiomata* may arise from the papillæ and give rise to copious hemorrhage. *Lipomata, fibromata, myxomata*, and *dermoids* have been observed, but are exceedingly rare.

Malignant tumors of the kidney are much more frequent than the benign varieties.

Hypernephromata.—These growths are of frequent occurrence, and arise from small aberrant masses of adrenal tissues beneath the capsule or imbedded in the substance of the organ. They appear as circumscribed yellow or reddish nodules beneath the kidney capsule, or as irregular nodular outgrowths involving a part of or the entire kidney. They may grow slowly, become apparently arrested, or at any time take on a rapid growth and reach an enormous size. The disease not infrequently extends into neighboring veins, and may give rise to an irregular metastasis. These metastases occur in any organ or tissue of the body, but appear more frequently in the bones and lung. The metastatic deposits preserve the histologic structure of the original growth. They rarely involve the lymphatics.

The tumor may remain for years as an innocent growth, but at a later period it almost invariably exhibits well-marked evidences of malignancy.

Like normal adrenal tissue, these tumors have the power of changing the blue reaction of starch and iodine into a pale pink color. A knowledge of this fact may enable one to make a rapid diagnosis at operation.

Sarcomata.—Sarcoma occurs most frequently in children under five and in adults between twenty and fifty. The growth, if of the small round-cell variety, is rapid, and the tumor may attain a large size, sometimes occupying one-half or more of the abdominal cavity. In the less malignant forms the growth is slower, and in adults may not prove fatal for two or three years.

Carcinomata.—Carcinoma of the kidney occurs in two clinical forms, an infiltrating growth of the parenchyma and an epithelioma of the pelvis. It occurs, as a rule, late in life, and is rapidly fatal. The epitheliomatous type is frequently associated with calculus of the pelvis, which in these cases probably acts as an exciting cause.

Symptoms.—The three most important symptoms of renal new growth are hæmaturia, tumor, and pain. At a late period in the disease there may be varicocele from pressure on the renal vein, and in malignant cases cachexia.

Hæmaturia.—In the majority of cases (50 to 60 per cent.) hæmaturia is the first symptom. It is spontaneous, may occur at night, and often is uninfluenced by exercise or rest. It is generally intermittent, and may be small in amount or very profuse.

Tumor is generally the first symptom in children, and in about one-fourth of the cases is the first symptom in adults. The characteristics which distinguish a renal tumor from growths in other organs are its position in the loin behind the colon, its characteristic shape, its rounded outlines, the fact that it obliterates the natural curve of the loin. but does not bulge backward, that its mobility is generally limited, and that it is never separated from the spine by an area of resonance. "Renal tumors never invade the bony pelvis, rarely reach the median line, and frequently are separated from the hepatic dulness by a resonant area" (Morris).

Pain.—This occurs as a primary symptom in about one-third of the adult cases. It is mild at first, located in the loin, and may radiate to the thorax or groin. It is intermittent, uninfluenced by exercise or rest, and occasionally is severe and resembles the colic of calculus.

Examination of the urine may be negative. Red blood-cells are, however, often found with the microscope when the macroscopic appearances are negative. A marked diminution in the amount of urea excreted is frequently observed as an early symptom (Rovsing).

As the majority of renal new growths are malignant, and as the prognosis is extremely grave unless the tumor is removed at an early period, it is the duty of the surgeon to investigate at once any case of symptomless hæmaturia. Cystoscopic examination and the collection of the urine from each kidney will determine the source of the hemorrhage.

Treatment.—In the presence of symptoms pointing to renal new growth an exploratory incision should be made in the loin for purposes of diagnosis. If the tumor is probably malignant, nephrectomy should be performed if the opposite kidney is known to be functionating satisfactorily and if the growth has not infiltrated the surrounding tissues. Non-malignant solid tumors should be removed by partial nephrectomy. This method is also applicable to echinococcus and other cysts, although they are often cured by incision and stitching the edges of the cyst to the skin. A unilateral large polycystic kidney sometimes gives rise to pain and other symptoms justifying its removal if the other kidney is healthy.

Cysts of the Kidney.

The cysts which occur in the kidney are the *simple serous cysts,* containing clear or slightly blood-stained fluid; the *echinococcus cysts,* which may reach an enormous size; the *dermoid,* and the condition described as *polycystic kidney.* The first three varieties are exceedingly rare.

Polycystic kidney occurs in both children and adults. In most of the cases the disease is congenital and bilateral. The entire kidney is often transformed into a mass of cysts of varying size, causing atrophy of the secreting substance and symmetric enlargement of the organ.

As the condition gives rise to no symptoms other than those of pressure and atrophy of renal tissue, many of these cases reach adult life, and the disease not infrequently is discovered by accident. Sooner or later, however, as the disease slowly progresses, a point is reached when the active renal tissue is not sufficient for the needs of the economy and symptoms appear. If in these cases an unusual demand is made upon the kidneys as a result of some metabolic disturbance or infectious disease, an acute condition of uræmia results.

Adrenal Tumors.

Hypernephromata or *sarcomata* may occur as primary tumors of the suprarenal gland. The relations of these glands to the kidneys are so intimate, however, that a differential diagnosis is rarely possible.

Cysts.—Adrenal cysts are rare, but have a fairly characteristic symptomatology. They may arise from the degeneration of solid tumors, from the follicles of the gland, from parasitic disease, or from hemorrhage. Virchow described a cystic condition which he regarded as similar to the cysts of the thyroid, and to which he applied the term *suprarenal struma.*[1]

Symptoms.—The symptoms of a suprarenal cyst are at first indefinite discomfort and a sense of fulness in the upper abdomen. Later there occurs a more or less typical attack of renal colic, the pain starting high up under the diaphragm and radiating downward or toward the umbilicus. These attacks are often accompanied by vomiting and prostration. At a still later period a tumor appears in the renal region, which has a tendency to grow upward and cause pressure on the thoracic viscera.

Treatment.—In the treatment of this condition an effort should be made to remove the cyst. This is best accomplished through the lumbar incision. If this is impossible, it should be permanently drained by stitching it to the abdominal wound.

THE SURGICAL TREATMENT OF NEPHRITIS.

The value of *decapsulation* of the kidney in chronic afebrile nephritis is still a disputed point. The original favorable reports of Edebohls had the effect of stimulating many surgeons to give the method a fair trial in these otherwise hopeless cases; and while there are some who have become enthusiastic advocates of the operation, and others who unqualifiedly condemn it, the majority of conservative surgeons who have given the method a fair trial agree that in a large proportion of well-selected cases, considerable benefit follows the procedure. While the author has never accomplished a positive cure by this operation, he has observed a number of cases in which a striking and rather unexpected improvement has resulted. This was particularly so in the case of a boy, aged eight years, who for four months had suffered from headache, œdema of the face and legs, and ascites. He had been repeatedly tapped, and the legs had been incised for the œdema. The urine showed the signs of a diffuse nephritis. After double decapsulation all the symptoms improved rapidly. The œdema disappeared, the ascites diminished, the headaches cleared, and his general health improved. The change was so striking, occurred so promptly after the operation, and presented such a marked contrast to the progressive deterioration of health while under medical treatment, that it convinced me of the value of the operation. This patient is still alive five years after the operation, but presents unmistakable evidences of chronic nephritis.

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[1] McCosh has recently reviewed the entire subject of adrenal cysts. His paper was published in the "Annals of Surgery," June, 1907.

The Treatment of Acute Nephritis by Decapsulation.—For the past four years the author has been interested in a study of acute hæmatogenous infection of the kidney, the unilateral type of which was described earlier in the chapter. During the progress of these studies, which were both clinical and experimental, he became convinced that in a large number of cases the so-called acute nephritis, which so often follows the exanthemata and other septic processes, and is characterized by total suppression or the passage of a very small amount of smoky highly albuminous urine, fever, œdema of the face and extremities ; and which so frequently ends fatally in a few days, differs in no respect from the acute unilateral type, except for the fact that both kidneys are involved.

Pernice and Scaglioni have shown that in their experimental work almost every known form of acute renal degeneration and inflammation, from a slight cloudy swelling of the epithelium to a complete destruction of the organ by multiple abscesses and purulent inflammation, can be produced by passage of the various pathogenic organisms through its vascular apparatus. This fact was also verified by the author in his experiments. In a case of postscarlatinal nephritis, with severe unilateral symptoms and evidences of grave and progressive sepsis, but with only a diminished output of urine, the writer performed a nephrectomy which was followed by rapid recovery. An examination of this specimen showed that it contained innumerable septic infarcts and differed in no respect from the other cases of acute unilateral sepsis except that the lesions were non-suppurative, and that cultures taken from a number of the gross lesions could not be made to grow on any of the ordinary media.

While many of these cases of so-called acute Bright's disease recover spontaneously, yet it is a well-recognized fact that in a large number of instances the kidneys are seriously and permanently damaged by the attack. In the writer's opinion the majority of individuals who suffer from chronic nephritis in early life can trace the origin of the affection to some such acute process.

If decapsulation has often a marked beneficial effect in the chronic terminal conditions of kidney infection, it would seem to the writer probable that a much more satisfactory result would follow if the operation were performed during the acute attack before permanent lesions were produced, and while the kidney tissue was still acutely hyperæmic and capable of rapid repair. That this is a fact is evidenced by a number of instances recently reported where decapsulation has resulted in a prompt subsidence of symptoms.

That the suspended function of the kidney can often be rapidly restored by this procedure is proved by the following case:

A married woman was admitted to the Roosevelt Hospital suffering from right-sided renal pain, some fever, and a diminished secretion of urine. Both ureters were catheterized. From the right only a few drops of smoky urine were obtained in forty minutes, from the left an abundant flow which was normal in appearance and chemical reactions. Right kidney exposed, and found to be the seat of numerous small elevated lesions (septic infarcts), the fatty capsule was thickened, infiltrated, and moderately adherent. The fibrous capsule was stripped from the organ and the wound closed. Fourteen days later, after complete healing of the wound, the ureters were again catheterized. From both there was an abundant flow, 12 cc. from the right and 15 cc. from the left in twenty minutes. Although the urine from the right kidney showed a trace of albumin, its percentage of urea was higher than that from the left, showing that its function had been practically restored. From these observations the writer feels that the indications for treatment in cases of acute bilateral hæmatogenous nephritis should be the same as in the unilateral type; and that early decapsulation should be advised whenever medical measures fail to bring relief and a fatal suppression is imminent. The operation, however, should be performed in the shortest possible time, with the minimum anesthesia and exposure on the table. It is advisable to have both kidneys operated upon simultaneously by two surgeons. Carried out in this way the operation occasionally can be performed in ten or fifteen minutes.

INJURIES AND DISEASES OF THE URETER.

Wounds of the Ureter.

The ureter is occasionally injured in severe traumata, especially in fractures of the pelvis, as a result of gunshot or stab wounds, and in surgical operations.

In subparietal injuries extravasation of urine occurs, followed, as a rule by abscess and evidences of septic intoxication. In open wounds a urinary fistula is established.

Symptoms.—In open wounds the diagnosis is easily established by the presence of urine or a urinous odor in the dressings; in subparietal ruptures the diagnosis is not so easily made. Localized pain, associated with hæmaturia, particularly if the latter is intermittent, is strongly suggestive of a wound of the ureter. A rapidly progressive swelling and œdema of the periureteral tissues in the absence of signs of hemorrhage indicates extravasation and renders the diagnosis practically certain.

Treatment.—Longitudinal wounds may be sutured or, if extraperitoneal, will heal spontaneously if proper drainage is secured. Complete division of the ureter is repaired best by Van Hook's method of lateral anastomosis. If the wound is too near the bladder to permit of this method, the distal portion should be securely ligated with silk and the proximal end implanted into the bladder.

If these procedures are impossible, implantation of the ureter into the bowel has been suggested, but is more dangerous than nephrectomy. Ligation of the proximal portion of the ureter and nephrostomy, as suggested by Watson, is the safest procedure where it is essential to preserve the kidney.

Ureteritis.

Idiopathic ureteritis has not been observed. The disease occurs only in connection with an infection of the bladder or kidney, or of both combined. This gives rise to two forms, the septic and the tuberculous.

Septic ureteritis exists as an acute or chronic process. In the acute form, the mucous membrane is injected, œdematous, and in places eroded. There may or may not be a peri-ureteral œdema. In the chronic form the tube is thickened, and if obstruction exists there is dilatation above the point of stricture; or if urethral stricture or prostatic enlargement give rise to the obstruction, the entire tube may be dilated, thickened, and tortuous. In the tuberculous variety the walls are irregularly thickened, giving a beaded appearance, and the mucous membrane is studded with tubercles or the ulcers resulting from them. If obstruction exists, dilatation is often present.

Symptoms.—These differ in no way from those of the accompanying kidney or bladder lesion. The pain is often sharply localized, and tenderness may exist along the course of the ureter, which may occasionally be palpated in thin subjects.

Treatment.—Direct application of antiseptic or astringent fluids to the diseased membrane in the septic cases has been practised with success by means of the ureteral catheter or by irrigation from above through a nephrotomy wound. These measures, however, are seldom necessary, as treatment addressed to the renal or bladder disease will usually be quite sufficient. The treatment of the tuberculous variety should consist in removal when nephrectomy is practised. Complete ureterectomy, however, is rarely practicable at the primary operation, owing to the difficulty in removal of the pelvic portion; nor is this necessary, for experience has demonstrated that a small segment of the ureter, even if extensively involved, seldom causes disturbance if the chief focus of the disease is successfully removed.

Stricture of the Ureter.

Stricture of the ureter may result from the various forms of ureteritis or the pressure of outside tumors or cicatricial bands. It also results from kinking of the ureter and impaction of a calculus. When the ureter is suddenly and completely obstructed, atrophy of the kidney results; when the obstruction is partial with occasional periods of complete closure, nephrectasis or dilatation of the renal pelvis occurs. As the dilatation progresses the cortical portion of the kidney is flattened and finally atrophies, converting the organ into a large oval thick-walled cyst. If no infection is present and the fluid consists simply of accumulated urine, the condition is called *hydronephrosis;* if pus is present, *pyonephrosis;* if the sac contains blood, which occasionally occurs as a result of trauma, the term *hœmatonephrosis* is used.

Symptoms of an acute obstruction of the ureter, as from the impaction of a calculus, are those of renal colic plus localized tenderness at the point of obstruction. The urine may be diminished in quantity and contain blood. In the slowly developing form of ureteral obstruction the symptoms are those of hydronephrosis, which will be described below.

Treatment.—This should, if possible, be inaugurated before the process has resulted in nephrectasis. When the symptoms point to an impacted calculus, the ureter should be exposed by a lumbar incision and the obstruction removed.

Hydronephrosis.

Hydronephrosis may result from any obstruction to the outflow of urine. If the obstruction is in the ureter from the various causes enumerated above, unilateral hydronephrosis occurs; if due to urethral stricture, prostatic disease, or a tumor of the bladder involving both ureteral orifices, the hydronephrosis is bilateral.

Symptoms.—In the early stages the symptoms are those of the obstructing lesion; later, there may be pain and a sense of weight in the lumbar region, and the gradual development of a renal tumor which may grow to an enormous size, filling half the abdominal cavity. Sudden cessation of all symptoms, with rapid disappearance of the tumor and marked polyuria, may take place (*intermittent hydronephrosis*) when the cause of the obstruction is of such a nature that it may be relieved by the growth of the renal tumor, as the twisting or kinking of a ureter in cases of movable kidney.

Treatment.—If possible, remove the cause of the obstruction. If due to movable kidney, this should be firmly anchored; if due to an easily located obstruction in the ureter, this should be exposed by a lumbar incision, and if possible remedied. If the point of obstruction cannot be accurately located, expose the kidney, incise, evacuate the fluid, and explore the ureter with a bougie from the pelvis to the bladder. If the obstruction cannot be relieved, or if the kidney is atrophied, perform nephrectomy.

Ureteral Calculus.

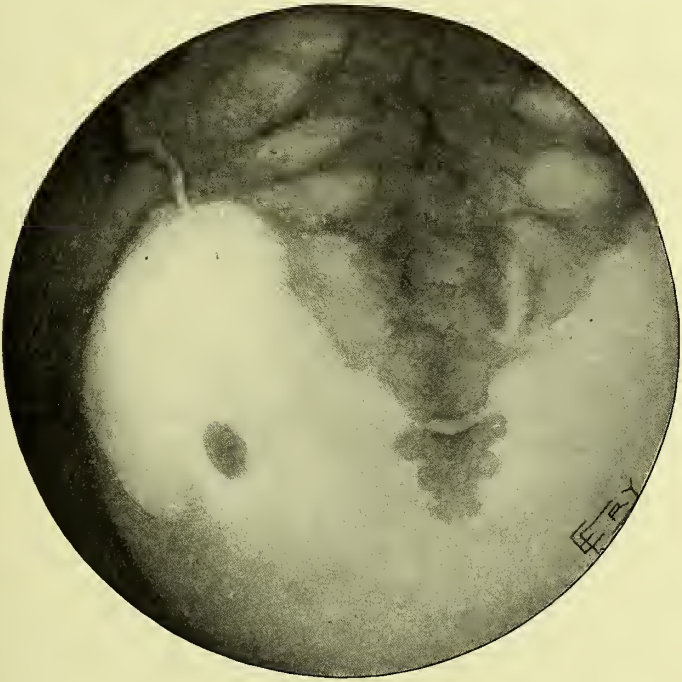
While a calculus in its descent from the kidney may become impacted in any part of the ureter, it is most likely to be arrested at its upper extremity, at or just below the pelvic brim, in the pelvic portion near the ischial spine or in the intramural segment. Ureteral calculi are generally oblong in shape, and rarely give rise to total obstruction. The irritation of an arrested calculus gives rise often to ulceration or thickening of the mucous membrane and other coats of the ureter, and produces more or less narrowing of the tube, which may effectively prevent its further progress toward the bladder.

Temporary obstruction frequently results from change in the position of the stone or from œdema of the adjacent mucous membrane. This gives rise to dilatation of the proximal portion of the tube and renal pelvis. Occasionally such an obstruction becomes permanant and a gradually increasing hydronephrosis results, which may at any time become infected by the blood-current or by an ascending process from the bladder or prostate.

Symptoms.—That an arrested ureteral stone may give rise to no symptoms is evidenced by the fact that in many instances in which a calculus is known to be lodged in the ureter, long periods of immunity from symptoms occur. Generally, however, stones in the ureter give rise to severe pain, which may be located over the site of the lesion or wholly confined to the kidney region. In the majority of cases typical renal colic occurs, the pain radiating downward from the kidney along the course of the ureter, and extending often to the glans penis or perineum.

If the stone is located in the lower portion of the tube, vesical irritability may be present. As in renal calculus, blood is often present in the urine, generally, however, in small amount, detected only by the microscope.

Fig. 240.



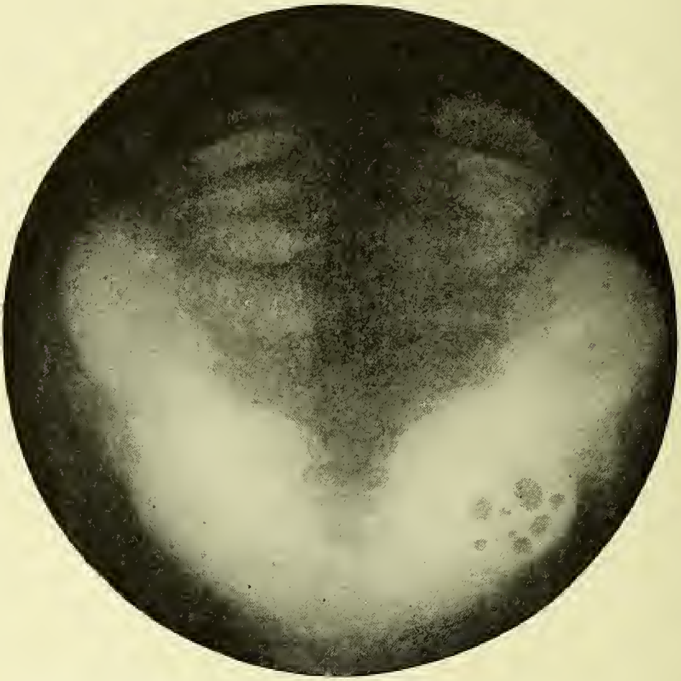
Radiogram of calculus in lower ureter. (From plate by Dr. L. G. Cole.)

Cystoscopy frequently reveals an œdema and eversion of the ureteral orifice. The ureteral catheter may or may not be arrested at the seat of the stone.

The most reliable sign of a ureteral calculus is the presence in an x-ray plate of a distinct shadow over the course of the ureter. In about 50 per cent. of the cases examined small round faint shadows are seen in radiographs of the adult pelvis. They are often multiple, and frequently lie somewhat below and to the outer side of the normal position of the ureter. These may be due to phleboliths, small areas of calcification in the sacral ligaments, or, as demonstrated by the writer on one occasion, to a calcified appendix epiploica of the sigmoid. An *x*-ray plate taken after the passage into the ureter of a catheter bearing a metal stylet will enable one to determine accurately the relation of these shadows to the ureter. Fig. 240 shows a typical radiograph of an ureteral stone; Fig. 241, the atypical shadows just described.

Prognosis.—The prognosis of ureteral stone is, in general, unfavorable, as the majority of stones which have become arrested for any length of time do not pass spontaneously; and as long as they remain in the ureter there is danger of permanant obstruction or of infection of the corresponding kidney. Occasionally small stones after remaining in the ureter for several days or weeks will be passed into the bladder. Cabot has reported a case where, in his opinion, such a result followed palpation of the region of the ureter for purposes of diagnosis, and the writer has observed two

Fig. 241.



False shadows suggesting ureteral calculi. (From plate by Dr. L. G. Cole.)

cases where arrested ureteral calculi were demonstrated by the *x*-rays and were subsequently discharged through the bladder and urethra.

Treatment.—Occasionally a ureteral calculus seen by the cystoscope projecting from the ureteral orifice can be dislodged by an ureteral catheter. Stones arrested in the intramural segment of the tube can be best removed by suprapubic cystotomy and slitting up the ureteral orifice. All stones situated in the ureter above its junction with the bladder should be approached by the lumbar or inguinal extraperitoneal route. Experience has demonstreted that this method is far superior to any of the older procedures.

In difficult cases Gibbon has advocated opening the peritoneal cavity for palpation, both to locate the stone and to assist in its removal by the extraperitoneal route. The technic of this operation will be described at the end of the chapter.

Tumors of the Ureter.

Primary new growths of the ureter are rare. Cysts, papillomata, epitheliomata, and sarcomata have been observed. Secondary involvement of the ureter by extension from other organs is more common.

The **symptoms** are pain, hæmaturia, nephrectasis, and the presence of a tumor in the region of the ureter.

The **prognosis** will depend on the character of the growth and the extent of ureter involved.

The **treatment** should consist in removal of the diseased portion of the ureter, and, if possible, anastomosis of the divided ends.

OPERATIONS ON THE KIDNEY AND URETER.

Before deciding upon any serious kidney operation it is important to determine, if possible, the functional competence of the opposite kidney. This, for obvious reasons, is particularly true in a contemplated nephrectomy; but it is also desirable to determine this point in other operations which, while they do not remove the diseased organ, may at least seriously interfere with its functional activity for a limited period of time. The methods of determining this are the following:

1. *Separation of the Urines.*—Obtain the urine from each kidney by means of ureteral catheterization or the use of the Harris segregator, and subject each specimen to a careful chemical and microscopic examination.

2. *Cryoscopy.*—Determine the freezing-point of the blood-serum, which is normally 0.56° C. A lowering of this point

indicates greater molecular concentration of the blood, and a consequent impaired functional activity of the kidney. A single healthy kidney will serve to maintain the freezing-point of the blood-serum at the normal point.

3. *The Phloridzin Test.*—Inject $\frac{1}{12}$ grain of phloridzin beneath the skin of the patient, after complete evacuation of the bladder by catheter. Obtain a specimen of the urine one-half hour after the injection, and another in one hour. If the kidneys are healthy, the first specimen of urine will contain from 0.4 to 0.5 per cent. of sugar, the second slightly less, the average being about 0.06 per cent. less than the first. In disease of the kidney the percentage of excreted sugar is decidedly less, generally about one-half the normal amount, and there is less difference between the first and second specimens. Watson, who has recently investigated the subject, states that in 11 out of 70 cases the findings were not reliable as furnishing indications for operation.

4. *The Methylene-blue Test.*—Inject 15 minims of a 5 per cent. sterile solution of methylene-blue beneath the skin. If the kidneys are healthy, the blue should appear in the urine in one hour after the injection; it should increase gradually in amount for five or six hours, and then slowly disappear. If the blue fails to pass through the kidneys, or is markedly delayed, renal insufficiency exists.

In the last two methods separation of the urine is necessary to determine which kidney is at fault.

5. *The Indigo-carmine Test.*—Inject 20 cc. of a 0.4 per cent. aqueous solution of indigo-carmine. Fifteen minutes later introduce a cystoscope and observe the urine flowing from each ureter. If the urine issuing from each ureter is of a deep blue color, and if the flow occurs in strong jets at regular intervals, it is evident that no obstruction exists, and it may be assumed that the kidneys are reasonably healthy. Absence of color in the urine indicates grave secretory disturbance.

Of all these methods the most reliable is a chemical and microscopic examination of the separated urines obtained by ureteral catheterization. It frequently happens, however, that ureteral catheterization is not possible even in expert hands. In these cases careful cystoscopic observation of the results of the indigo-carmine test will afford fairly reliable data. In complicated cases, as pointed out by Edwin Beer, a combination of both methods is of advantage.

Cryoscopy gives misleading results at times, for while it will indicate with positiveness the fact that there is sufficient normal secreting renal tissue somewhere in the body, it does not indicate in which organ this tissue is located, and as Rovsing has pointed out in bilateral renal disease, the kidney giving rise to the most painful and distressing symptoms may contain the greater amount of secreting tissue. Beer has also pointed out that a functionally disturbed kidney may cause a sufficient molecular retention to lower the freezing-point to a dangerous level (0.60° C.) without there being any organic disease which would contraindicate operation.

Too much reliance should not be placed on any of these methods in determining the advisability of operation on a septic kidney, as impairment of function in the presumably sound kidney may be temporary in character, due to the toxæmia induced by the sepsis, and may rapidly disappear after removal of the septic focus.

Exposure of the Kidney.

The kidney can be exposed by several incisions.

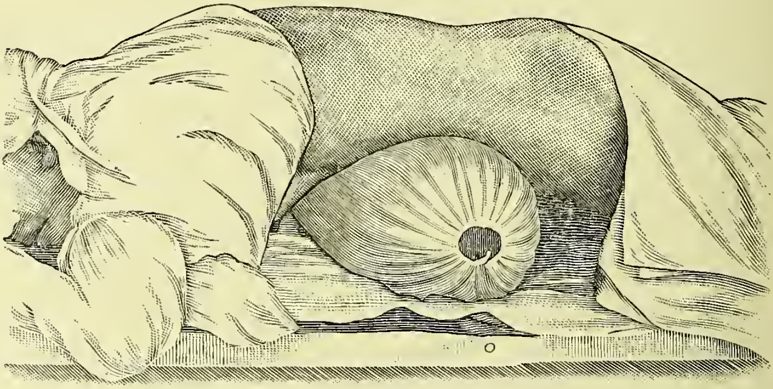
The Posterior Vertical Incision (Edebohls).—The patient should be placed prone on the table, with a cylindric inflated rubber bag under the abdomen (Fig. 242). The incision should be along the external border of the erector spinæ muscle, dividing skin, superficial fascia, latissimus dorsi, and lumbar aponeurosis. The retroperitoneal space is opened and the kidney exposed by tearing apart the perirenal fat, which will be found in two layers separated by the thin perinephric fascia. The last dorsal and iliohypogastric nerves will be exposed. The kidney can generally be brought out through this incision and thoroughly examined.

The Oblique Lumbar Incision.—The patient should be placed in Sims' position, with a large pad under the healthy loin. The incision should begin over the junction of the sacrolumbalis muscle with the last rib, and extend obliquely to or near the anterior spine of the ilium. The skin and fat are divided, the latissimus dorsi and external oblique separated or divided, the lumbar aponeurosis incised, and the perirenal fat exposed. If more room is needed, the incision may be extended from below forward and upward toward the umbilicus (König), or downward parallel to Poupart's ligament, separating the fibres of the external oblique and dividing those of the internal and transversalis. By these incisions the entire retroperitoneal space can be exposed from the under surface of the liver to the pelvis. The former method is useful in large tumors of the kidney ; the latter, in operations upon the ureter.

Nephrolithotomy.

Nephrolithotomy is an incision into the kidney for the removal of a calculus. The kidney may be exposed by either of the above-mentioned incisions, the organ and pelvis palpated for evidences of stone, or needled, preferably with a blunt-pointed steel knitting-needle. If a calculus is detected, an incision should be made upon it either through the convex border or directly through the pelvis. After removal of the stone the pelvis should be thoroughly explored with the finger and the patency of the ureter established by the passage of a bougie. If no stone is detected by palpation or needling, the pelvis should be opened through the cortex and its cavity explored. It not infrequently happens that incision through an hyperæmic cortex gives rise to troublesome hemorrhage. To avoid this the writer has been in the habit of opening the pelvis in the following manner: The thumb and forefinger are placed on either side of the pelvis; a grooved director is next passed through the cortex into the pelvis, a closed pair of dressing forceps passed along the groove in the director into the pelvic cavity and withdrawn partly open. By this method none of the larger vessels are divided.

FIG. 242.



Edebohls' kidney air-cushion, with patient in position for operation.

Nephrotomy.

Nephrotomy is an incision into the kidney for the evacuation of an abscess or the relief of nephrectasis. In opening the pelvis of the kidney through its convex border it is desirable to make the incision half an inch posterior to the median line of the organ, as it has been shown that the renal tissue in this plane is less vascular than in other portions.

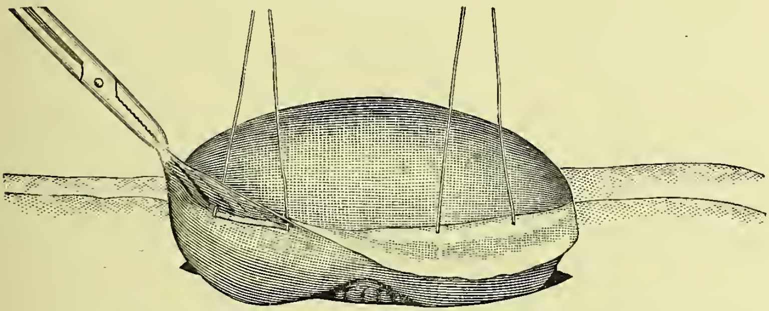
Nephrectomy.

Nephrectomy may be accomplished through a lumbar incision, or by means of the transperitoneal route. The former method is generally to be preferred. The kidney is exposed best by the oblique lumbar or König incision, the pedicle isolated, the vessels ligated separately or in two masses by means of strong chromicized catgut, and divided. The ureter is ligated separately, and after division touched with pure carbolic acid or the actual cautery. In tuberculous or septic disease of the ureter it should be freely exposed and as much removed as possible. The wound should be closed by layer suture with drainage. If the *abdominal route* is to be employed, a long vertical incision is made near the outer border of the rectus muscle separating its fibres. After opening the peritoneal cavity the parietal peritoneum is divided along the outer border of the colon, and the gut pushed well toward the median line, exposing the kidney and its pedicle. After abdominal nephrectomy drainage should be established through an incision in the loin.

Nephropexy.

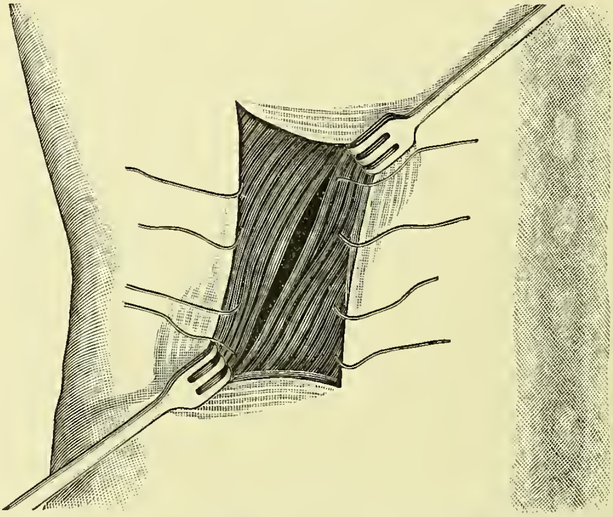
Nephropexy is practised for the purpose of anchoring a movable kidney. This is accomplished best by means of the method of Edebohls through the posterior vertical incision. After the organ is exposed, its fatty capsule should be dissected away and the fibrous capsule stripped backward from an incision along the convexity. The quadratus lumborum fibres are exposed by a division of its sheath. Four chromicized catgut sutures are then passed longitudinally through the folded capsule, two in each side. Both ends of each suture are next passed outward through the muscle

Fig. 243.



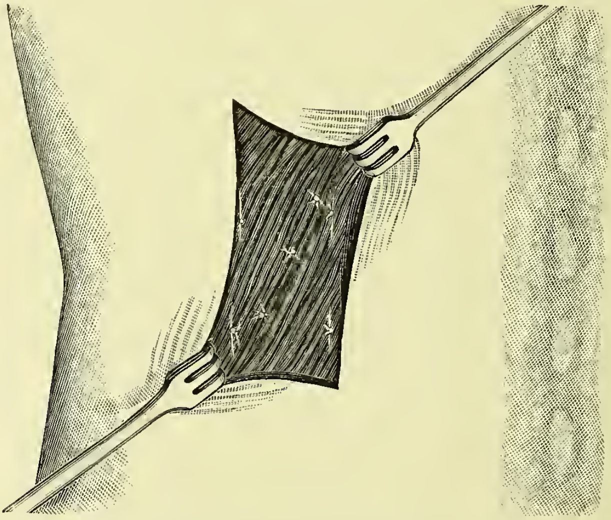
Showing two of the four suspension sutures passed through reflected and attached layers of capsule proper, without penetration of kidney-substance. The two companion sutures, passed on the opposite face of the kidney, are not shown.

Fig. 244.



The kidney has been replaced and the ends of the suspension sutures have been brought through the abdominal wall, emerging on the outer surface of the latissimus dorsi. The fibres of the muscle have been separated from each other, not cut, in making the incision.

Fig. 245.



Suspension sutures and sutures closing deep parts of wound tied.

and divided lumbar aponeurosis, those from the posterior portion of the renal capsule emerging through the posterior lip of the incision, those from the anterior layer through the anterior lip. On drawing these four sutures tight, the denuded convex border of the kidney is brought in contact with the edges of the wound and the exposed fibres of the quadratus muscle. The muscular and aponeurotic layer is next closed by interrupted sutures, after which the fixation sutures are tied parallel with the wound. The skin should then be sutured with silk or silk-worm gut. The patient should be kept in bed three weeks (Figs. 243, 244, 245).

Ureterotomy and Ureterectomy.

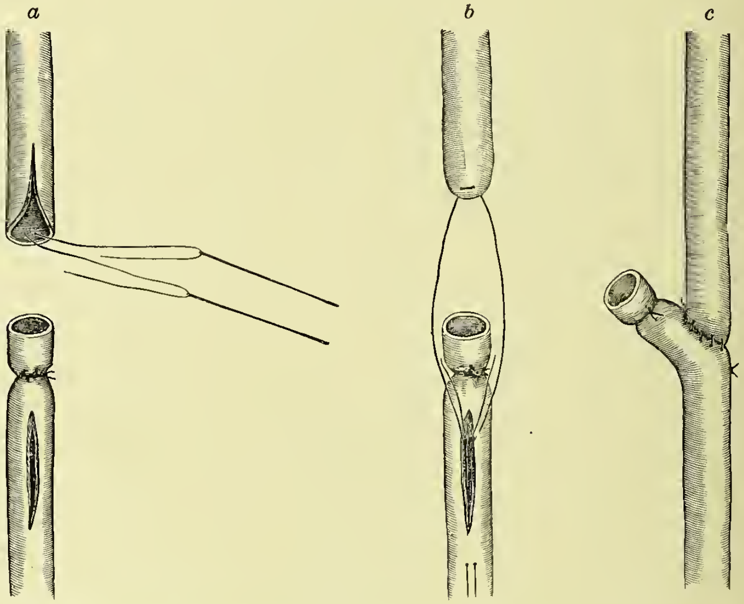
Ureterotomy is indicated for the removal of a calculus; ureterectomy, for tuberculosis or new growth. The ureter in its upper portion may be exposed by the oblique lumbar incision. The middle portion of the ureter may be exposed by an extension downward of the oblique lumbar incision to the iliac region, and retracting the peritoneum well toward the mid-line, exposing the psoas muscle. To expose the lower or pelvic portion of the ureter several methods have been suggested. The simplest and safest is the iliac extraperitoneal route. An incision is made parallel with Poupart's ligament from a point two inches above the anterior superior spine of the ilium to a point about one inch above the external abdominal ring. This divides the skin and superficial fascia. The aponeurosis of the external oblique is split, and the internal oblique and transversalis divided transversely, exposing the subperitoneal fat. The peritoneum is next separated from the iliac muscle and side wall of the pelvis toward the mid-line and held by broad retractors. The ureter will generally be found attached to the retracted peritoneum, and can be easily separated and palpated to its entrance into the bladder. In ureteral calculus it is desirable, if possible, to push the stone upward and remove it through a longitudinal incision in the healthy ureteral wall. Such a wound in the ureter may be united with fine silk or catgut sutures. In the lumbar region the ureteral wound may be left unsutured if adequate drainage is provided.

For the removal of the entire ureter in the female, Kelly advises the combined lumbar and vaginal method.

Uretero-ureterostomy.

Uretero-ureterostomy is an operation for divided ureter. Carrel in his experimental work has employed end-to-end suture of the divided ureter, using fine silk and the technic described for arterial or venous anastamosis. He finds the method satisfactory where the ureter is fairly large, but in smaller animals stricture has almost invariably followed. To one unaccustomed to such work the method of Van Hook would be simpler and perhaps less likely to be followed by stricture. Ligate the lower segment of the ureter with strong silk, make a longitudinal incision into the tube just beyond the ligature, and draw the upper segment through this opening by means of a loop of catgut passed through the tip of the upper end, and then inward through the incision and outward through the healthy ureteral walls beyond the incision. This is tied, and one or two other sutures inserted about the line of junction, or the union protected by means of a fold of peritoneum (Fig. 246). If there is considerable loss of ureteral tissue and the ends cannot be approximated, the kidney may be loosened from its attachments and brought downward in the loin until the ends meet (Bovée).

FIG. 246.



Uretero-ureteral anastomosis, end-in-side implantation (Van Hook's method): *a*, first step; *b*, second step; *c*, completed operation. (Bryant.)

Implantation of the Ureter into the Bladder.

Implantation of the ureter into the bladder must be undertaken if the distal end is too short to admit of anastomosis. Ligate the distal end and make an incision into the bladder near the ureteral orifice, draw the upper segment of the tube into the bladder by means of a loop of catgut as in Van Hook's method of anastomosis, introduce a few interrupted sutures at the line of union, and protect with a fold of peritoneum or omentum.

CHAPTER XXI.

INJURIES AND DISEASES OF THE BLADDER AND URETHRA.

INJURIES AND DISEASES OF THE BLADDER.

Contusion.

Contusion of the bladder may occur from any injury which results in a contusion of the lower abdomen or fracture of the pelvis. It may occur also as a result of the careless use of sounds, catheters, or other instruments. The symptoms of a contusion of the bladder may be hæmaturia and temporary vesical irritability. As a rule, no treatment is required other than rest.

Penetrating Wounds.

Penetrating wounds of the bladder may result from gunshot or stab injuries through the lower portion of the abdominal wall, from wounds through the tissues of the perineum, from the unskilful use of urethral or bladder instruments, or from accidental incisions during the performance of surgical operations on neighboring structures. As the symptoms and treatment of these rare injuries are similar to those of the more commonly observed ruptures of the bladder, they will be considered in connection with the latter in the following section.

Rupture of the Bladder.

This injury may result from a blow on the lower abdomen when the bladder is full, from fracture of the pelvis, with or without penetration of a spicula of the broken bone, or from simple over-distention from some pathologic condition producing complete obstruction of the urethral canal, especially if there is present in the bladder-wall malignant ulceration or a thin-walled saccular diverticulum. Ruptures of the bladder are divided into two general classes, the *intraperitoneal* and the *extraperitoneal ruptures.* In the former the rent occurs through the posterior or postero-lateral wall, and the extravasated urine passes into the peritoneal cavity; in the latter the injury occurs in the extraperitoneal portion of the viscus and the extravasated urine collects in the prevesical space. Occasionally ruptures of the bladder involve both the intraperitoneal and extraperitoneal portions of the vesical wall. Intraperitoneal ruptures are the graver injuries on account of the probable infection of the peritoneal cavity. In ruptures accompanied by fractures of the pelvis there is, in addition, frequently a rupture of the iliac vessels, with severe hemorrhage and the formation of large retroperitoneal hæmatomata.

Symptoms.—If the rupture is an extensive one, there are symptoms of severe shock: pallor, weakness, rapid, feeble pulse, cold extremities, nausea, vomiting, giddiness, and cold perspiration. In addition there are severe pain in the lower abdomen and an urgent desire to pass urine. Efforts to empty the bladder result only in the passage of a few drops of bloody fluid which does not materially relieve the tenesmus, and the introduction of a catheter demonstrates an empty bladder. If the rupture is intraperitoneal, free fluid may occasionally be detected in the peritoneal cavity; if extraperitoneal, the extravasated urine collects in the space of Retzius, and appears as an indurated swelling which may sometimes be appreciated by rectal as well as abdominal palpation.

The introduction of a given quantity of boric acid solution through a catheter into the bladder and noting the amount returned, will often serve as a valuable indication both of the presence of rupture and, to a certain extent, of the size of the rent. In untreated cases death generally results from peritonitis, uræmia, or extensive suppuration and sepsis.

Treatment.—In the presence of symptoms suggesting a rupture of the bladder, the first indications are to ascertain if the injury involves the peritoneal portion of the organ; and if not, to locate accurately the extravasation and hæmatoma. These are best met by a median exploratory laparotomy. The incision should be made between the umbilicus and pubes, and when the peritoneal cavity is opened the presence or absence of blood or extravasated urine is demonstrated. If the rupture is intraperitoneal, the incision should be enlarged, the rent in the bladder-wall united with two rows of sutures, the first of catgut uniting the muscular coat, the second of silk infolding the peritoneum with Lembert or Halsted stitches. The entire cavity of the peritoneum should then be flushed with sterile salt solution and the abdominal wound closed with a small cigarette drain.

If the rupture is found to be extraperitoneal, the abdominal wound should be tightly closed and an incision made over the prevesical space. This should be freely exposed, if necessary, by a transverse partial division of the attachment of the rectus muscles. The tear in the bladder-wall should be united by two or three layers of sutures, the most external of which should be of chromic gut or silk; the extravasated urine and blood should be thoroughly removed, any bleeding points secured by ligature or gauze packing, and perineal drainage established.

It frequently happens that rupture is produced by the penetration of a fractured fragment of the horizontal ramus of the pubes, and the resulting wound is large, ragged, severely contused, and situated low down, just above the prostate. Under these conditions accurate suture is difficult, if not impossible, and it is better to unite the wound partly and establish suprapubic drainage. Generous drainage of the prevesical space should be employed in all cases of extraperitoneal rupture, as infection is almost always present, and not infrequently considerable sloughing of the bladder-wall occurs, leaving a large rent which heals very slowly. In these cases, as in all cases of suprapubic drainage, the employment of intermittent siphon drainage is of great value, not only in contributing to the comfort of the patient, but by prompt removal of all infected fluids.

It occasionally happens in fractures of the pelvis that the triangular ligaments are extensively torn. This will often give rise, through cicatricial contraction, to obstinate urethral obstruction, which develops late, after perineal drainage has been abandoned, and not infrequently prevents closure of the suprapubic fistula. This complication should be met by the use of sounds, and if necessary by external urethrotomy.

Long-continued perineal drainage, or the presence of an extensive suprapubic opening, will result in a contraction of the bladder, which may become so reduced in size as to hold only a few drachms of fluid. This condition should be overcome by systematic daily stretching of the bladder by the introduction of fluid through the urethra, the suprapubic opening being closed if possible by digital pressure. The procedure is often a difficult one, but is most important for the future comfort of the patient.

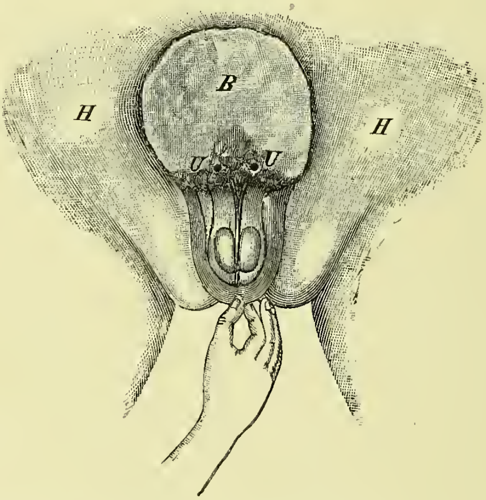
Foreign Bodies in the Bladder.

The introduction of foreign bodies through the urethra is of fairly frequent occurrence, especially in females. Hair-pins, pencils, bits of wax or gum, and many other substances have been found by surgeons. In those who habitually use the catheter it sometimes happens that an old or brittle instrument will break during its introduction or withdrawal, leaving one or more inches in the bladder. These foreign bodies give rise to cystitis, eventually become encrusted with phosphatic salts, and cause symptoms identical with those of vesical calculus.

Congenital Malformations of the Bladder.

Exstrophy.—This is a failure of union of the two lateral halves of the anterior wall of the bladder and the overlying soft parts, which results in exposure of the posterior wall of the bladder with its ureteral openings just above the pubes. The malformation is apt to be associated with a failure of union of the pubic arch, and a condition of complete epispadias in the male and a bifid clitoris in the female (Fig. 247). In the milder forms of the deformity the genitals may be normal, and only a fissure in the anterior wall of the bladder may be present. Occasionally the fissure is limited to the abdominal wall, through which a perfectly closed bladder may protrude. In its worst form the malformation is a distressing one, rarely capable of correction. The urine flows over the abdomen and thighs, excoriating the skin and keeping the patient and his clothing constantly wet and offensive. The exposed mucous surface becomes inflamed, sensitive, and easily bleeds.

Fig. 247.



Exstrophy of the bladder combined with epispadias: *B*, posterior wall of the bladder; *U*, *U*, orifices of the ureters; *H*, *H*, inguinal hernia on each side. (Tillmanns.)

The **treatment** of this condition consists in three methods: first, cleanliness and the use of some closely fitting rubber receptacle to collect the urine and avoid soiling the clothing; second, an attempt to repair or reconstruct the anterior bladder-wall by plastic operation; and third, to divert the course of the urine elsewhere, remove the mucous membrane, and promote cicatrization by skin-grafting. In case of simple fissure, closure may often be accomplished by freshening the edges of the cleft, and subsequent layer suture as in other bladder fistulæ. In more aggravated cases extensive plastic operations are necessary to construct an anterior wall to the bladder. For this purpose flaps are taken from the abdominal wall, thighs, prepuce, or scrotum, turned inward, so that the cutaneous surface will be united with the mucous membrane and form the inner lining of the newly constructed reservoir. The raw surface of this flap is then to be covered by additional flaps or skin-grafts. The results are rarely satisfactory. If the ureters are to be implanted into the rectum or sigmoid, a small area of the bladder-wall surrounding the ureteral orifice should be left attached to the freed ureter, in order to preserve the sphincteric apparatus which seems, in some cases, to act as a barrier to an ascending infection. Numerous other methods have been proposed, including that by Trendelenburg, who suggested division of the sacro-iliac joints and crowding the pelvic halves together, thereby converting the exposed mucous surface into a longitudinal sulcus, which later could be easily closed. While some measure of success has occasionally followed all of these methods, the condition of these unfortunate patients, at best, is deplorable. The author is inclined to believe that the most rational plan to follow in the graver cases is that suggested by Watson, to perform double lumbar nephrostomy, ligate, and divide the ureters, and close the abdominal defect by removal of the mucous membrane, this to be followed by skin-grafting or a plastic operation.

Other congenital malformations are: *double bladder*, by a vertical septum or transverse constriction; *diverticula* of the mucous membrane alone or with the muscular wall; and a *patent urachus* through which urine may be discharged at the umbilicus.

Cystitis.

Cystitis is inflammation of the mucous membrane of the bladder. This is an extremely common affection, and is invariably occasioned by the introduction into the viscus of pathogenic micro-organisms. These may gain entrance by an extension upward of an inflammatory process from the urethra, or downward from the kidney, by the introduction of urethral or bladder instruments, by the rupture of an infected focus into the bladder, by the transmission through diseased tissues of bacteria, or by the blood- or lymph-channels.

Exclusive of the tuberculous form of the disease, the following micro-organisms are, in the order of their frequency, most commonly responsible for the disorder: the gonococcus, the colon bacillus, Streptococcus pyogenes, Staphylococcus pyogenes, Diplococcus ureæ liquefaciens, and the typhoid bacillus. Some of these organisms have the power of decomposing urea, setting free ammonia, and thereby rendering the urine alkaline. Certain factors act as predisposing causes of the disease and serve to prevent resolution after the inflammation has occurred. These are: the presence in the bladder of tumors, calculi or other foreign bodies, and obstruction to the normal outflow of the urine by prostatic or urethral disease. If the inflammation is limited to the mucous coat, this is thickened and reddened, and minute ulcerations and hemorrhages may occur, espcially in cases in which calculi or other foreign bodies are present. Interstitial cystitis and pericystitis occasionally occur as a result of an extension outward through the mucous coat of a severe gonorrhœal or septic infection. This results in great thickening of the bladder-walls and contraction of the organ, often to the capacity of a few drachms.

Symptoms.—In *acute* cystitis there are localized pain and a frequent desire to urinate. The pain may be constant, as a dull ache or feeling of discomfort over the pubes or in the perineum; or it may be limited to the act of micturition, when it radiates along the urethra, and occurs with greatest intensity at the close of the act.

Vesical tenesmus, or straining to eject the last drop and a feeling of more to come, after the bladder has been emptied, is characteristic of the severer types of the affection; these cases also are often accompanied by fever and malaise; the patient becomes exhausted from loss of sleep, owing to the frequent calls to urinate. In the milder forms of the disease there may be only a slight frequency in urination, and the patient may be unaware of the presence of disease until his attention is called to it by his medical adviser. In all cases of cystitis pus is present in the urine. It may be small in amount, giving rise to only a slight cloudiness, or it may be present in such quantities as to produce a thick, creamy precipitate on standing. In addition to the pus, squamous epithelium, mucus, and blood are often found. If decomposition has taken place, the urine is ammoniacal, neutral or alkaline in reaction, and contains crystals of the triple phosphates. In the chronic forms of the disease the pain and constitutional symptoms are, as a rule, wanting. Slight frequency may exist; the urine is cloudy, generally ammoniacal, and presents a sediment of a thick, ropy material resembling mucin.

Diagnosis.—While pain, frequency of micturition, vesical tenesmus, and pyuria constitute the characteristic symptoms of cystitis, they are also present in other conditions, as pyelitis, posterior urethritis, suppurative prostatitis when the abscess communicates with the urethra, and in seminal vesiculitis. In pyelitis the pain and frequency are rarely severe, and are often absent, the amount of pus is greater than in cystitis, the urine may be acid, is generally albuminous, and bladder epithelia are not in excess. In posterior urethritis the pain, frequency, and tenesmus are, as a rule, more severe, the amount of pus is comparatively small, and the prostatic urethra may be tender to rectal palpation. If the urine is passed into two glasses, the first urine contains more pus than the second, and in addition numerous shreds of rolled-up pus or mucus. In prostatitis with a discharge of pus into the urethra there is generally a history of severe pain, tenesmus, and retention, followed by sudden relief and the appearance in the urine of a large quantity of pus. The enlarged and tender prostate can also be felt by the rectum ; bladder elements are not in excess, and the pain, frequency, and tenesmus, if they continue at all, are mild in character. Seminal vesiculitis rarely gives rise to marked pyuria, and in the presence of acute symptoms the enlarged and tender vesicle can always be felt by rectal examination.

Treatment.—In the acuter forms of the disease rest in bed, the ingestion of a large amount of pure water, the internal administration of urotropin in doses of from 7 to 15 grains two or three times a day, and suppositories of opium or morphine, constitute the early treatment. If the symptoms do not quickly subside, the bladder should be washed out once or twice each day with a saturated solution of borax or boric acid, followed by a solution of silver nitrate in a strength of 1 : 8000 to 1 : 3000. The use of potassium permanganate, protargol, or argyrol is also to be recommended, but they are inferior to the silver nitrate in the majority of cases. These solutions should be introduced through a sterile soft-rubber catheter passed with the greatest gentleness and under the strictest aseptic precautions. In addition to the above treatment, the cause of the cystitis, if still present, must be sought for and removed, as well as any factor which prevents or retards recovery, as stricture, stagnation of urine, etc.

As chronic cystitis is almost always dependent upon some definite cause, as stricture, prostatic hypertrophy, pyelitis, or calculus, the treatment of these conditions is of the highest importance, and should always be associated with the local measures addressed to the bladder.

Bacteriuria.

Bacteriuria is a name given to a condition which is characterized by the presence in the urine of large quantities of bacteria, which, however, have little or no tendency to create an inflammation of the mucous membrane of the bladder. The micro-organisms apparently grow in the urine, the contamination taking place from some small focus. This focus is usually located in the kidney, and is due to one or more insignificant septic infarcts, caused by some mild blood infection. Other sources of infection may be found in the seminal vesicles, in a follicular abscess of the prostate, the sinus pocularis, or one of the ejaculatory ducts. From these sources a certain number of micro-organisms are constantly discharged into the bladder. The organism most commonly present in these cases is, according to the observations of Jeanbrau, the colon bacillus; next in frequency is the staphylococcus albus; bacillus typhosus, bacillus subtilis, and the proteus have also been reported. The micro-organisms multiply rapidly, develop toxins which may become absorbed, and give rise to more or less local discomfort, mental depression, and general ill-health. The urine is cloudy and often foul smelling. On microscopic examination very few pus-cells are found, but large quantities of bacteria are invariably present.

The symptoms are rather indefinite; occasionally there is frequency in urination, with more or less pain. More often local symptoms are absent, and only a general feeling of ill-health or neurasthenia may be present.

The treatment should consist in finding the original focus and removing it. Washing out the bladder is of no value. If the focus is located in the prostatic urethra, deep injections of silver nitrate and massage may be of benefit. If the focus cannot be found, the systematic internal use of urotropin often will bring about a cure.

Hæmaturia.

While hæmaturia is only a symptom, it occurs so frequently in connection with grave genito-urinary lesions that a brief consideration of its causes may not be out of place.

Hæmaturia may arise from lesions of the urethra, prostate, bladder, ureter, or kidney. In hemorrhage from the anterior urethra the blood flows continuously from the meatus and does not contaminate the bladder urine. Blood from the posterior urethra flows backward into the bladder and does not, as a rule, appear at the meatus. Urethral hemorrhrge may be caused by trauma from external violence or from the use of instruments; from new growths or a granular posterior urethritis. It may also occur as a late symptom in malignant disease of the prostate. In these cases, where the source of the bleeding is in the posterior urethra, the bladder urine is uniformly discolored, but the last few drops passed may be almost pure blood.

Hemorrhage of the bladder may be due to trauma, external or internal; to hyperacute inflammatory conditions, to calculus, to tuberculosis, to new growth, or to the sudden relief of an extreme retention. The amount of blood, as a rule, is greatest in new growth, least in inflammatory conditions; when due to calculus, the amount is generally between these two extremes. In vesical hæmaturia the urine is uniformly mixed with the blood, except in the severest cases, where it may be present in such large amount as to produce clots. If the lesion is situated in the trigone, the last few drops passed may be pure, bright blood.

Hemorrhage from the kidney may be caused by trauma, inflammatory conditions, especially the acute hæmatogenous infections, calculus, aneurism, or new growth. If the hemorrhage is abundant, renal colic is produced from the passage of clots along the ureter. These long, worm-like clots sometimes may be seen in the bladder by the cystoscope, and are occasionally passed during urination. If the amount of blood is small, the urine may be slightly or not at all discolored; if larger in amount, the urine appears smoky; if the hemorrhage is very abundant, the color is brighter, and ureteral clots are present.

All of these conditions are described at length in the other sections.

Of the other rarer forms of hæmaturia, there may be mentioned the hæmaturia of scurvy, of malaria, of a chronic interstitial nephritis, and that due to parasites.

Under the parasitic diseases, two are well recognized as being the cause of hæmaturia, the *Filaria sanguinis hominis* and the *Bilharzia hæmatobia.*

Filaria Sanguinis Hominis.—This worm is supposed to enter the human body by drinking-water or through inoculation by mosquitoes, in the bodies of which the embryos primarily develop. The adult worms inhabit the lymphatics and reproduce each night hundreds of fresh embryos, which may be detected in the blood by the microscope. The parent worms occasionally may be found in the lymphatic vessels, but never in the blood. They are long, thread-like, translucent bodies. The female is much larger than the male, and may measure two or three inches in length. The parent worms cause obstruction in the larger lymphatic vessels by their presence alone, or by an inflammatory thickening which their presence begets. When the thoracic duct or some large mesenteric tributary is thus obstructed, dilatation of the peripheral branches causes extensive lymph-angiomata, which may rupture, giving rise to chylous ascites, chylous hydrocele, or chiluria. Lesions which rupture into the urinary passages may also give rise to an associated hæmaturia.

The disease is common in tropical countries, but rare in the United State or on the continent of Europe.

Bilharzia Hæmatobia.—The disease prevails extensively in Africa, in India, and in a few other tropical localities. Two or three cases have been reported which apparently developed in the central portion of the United States. The Bilharzia hæmatobia is a fluke 10 to 20 mm. in length, the female being larger than the male. It enters the human body by drinking-water. The adult worms inhabit the venous system, particularly the portal. The female deposits large numbers of eggs in the smaller vessels, which eventually cause a rupture of the vessel and the escape of the ova into the tissues, where they give rise to various lesions. Most of these lesions occur in the urinary tract, and may be found in the kidneys, the ureters, bladder, and urethra. The lesions, for the most part, consist in hyperæmic patches or papillomatous granulations.

The chief symptom of the disease is an abundant and persisting hæmaturia. Calculi frequently develop and, in the advanced stages of the disease, inflammatory lesions, abscesses, and urinary fistulæ.

As in many other parasitic diseases, blood examinations in these show a moderate leucocytosis with a high percentage of eosinophiles.

Treatment.—In regard to the treatment of these parasitic diseases, little or nothing can be accomplished by drugs, except to relieve the painful terminal symptoms. In a few instances of filiarisis the finding and surgical removal of one or more parent worms in a mass of dilated lymphatics has greatly relieved the symptoms, and although one can never be sure that other worms are not present, an attempt to find and remove them is justifiable.

Tuberculosis of the Bladder.

While tuberculosis may occur primarily in any part of the genito-urinary tract, there is a growing belief among surgeons that, in the vast majority of instances, it makes its first appearance either in the kidney or the epididymis. From each of these locations it progresses toward the bladder, following in each instance the direction of the fluid current in the ureter or vas deferens. As the route from the kidney to the bladder is shorter and more direct than from the epididymis, and as renal tuberculosis is of more frequent occurrence than tuberculous epididymitis, bladder tuberculosis is more frequently a sequel of kidney disease. As early tuberculosis of the kidney and epididymis gives rise, as a rule, to no painful symptoms, the irritation produced by the secondary lesion in the bladder is often the first indication of the pathologic condition, and for that reason the primary lesion is not infrequently overlooked. The disease, as a rule, is located in the vicinity of the trigone; if secondary to involvement of one kidney, the region surrounding the orifice of its ureter is first involved. The disease first appears in the form of miliary tubercles, which coalesce, forming indurated areas or ulcers with infiltrated borders. These may extend and form larger ulcerated areas, from which shreds of necrotic tissue may be cast off and appear in the urine.

Symptoms.—Tuberculosis of the bladder may remain latent for a long period, and only give rise to symptoms on the occurrence of a secondary infection or source of irritation. Thus the occurrence of an acute gonorrhœa or the passage of an unclean sound or catheter may give rise to a cystitis which may awaken a latent tuberculosis and render the diagnosis exceedingly obscure. The symptoms are those of a slowly developing cystitis; frequency in urination, pain at the close of the act, slight tenesmus, and the presence of pus and blood in the urine. These symptoms progressively increase in severity, slowly at first, but more rapidly toward the end. There is, as a rule, a gradual deterioration of the general health, with afternoon fever, occasional sweats, and loss of weight and strength. As the disease progresses the bladder symptoms become more marked, the pain is constant, and the calls to urinate become more frequent until the urine is almost continuously expelled by frequent spasmodic efforts, each of which is accompanied by excruciating pain and tenesmus. An absolute diagnosis of tuberculosis can only be made by the demonstration of tubercle bacilli in the urinary sediment, either by the microscope or as a result of animal inoculation. In the earliest stage of the affection the cystoscope will show an œdematous hyperæmic area about the mouth of the affected ureter. Later, the disease extends over the trigone and toward the other ureter, and at a still later period characteristic ulcerations may be seen.

Treatment.—As a rule, all local measures serve only to exaggerate the symptoms and cause the disease to advance with greater rapidity. In the early stages an out-of-door life among the pines in a high altitude or a long sea-voyage will often produce a rapid and marked improvement in all the symptoms. Not infrequently such patients may live for years under these conditions in comparative comfort; but as soon as city life is resumed the symptoms reappear and the disease progresses. General tonic measures, creosote, cod-liver oil, iron, and arsenic are indicated. If the pain becomes unbearable, permanent suprapubic drainage is to be recommended. Early suprapubic cystotomy with direct application of strong antiseptic agents to the local lesions has been frequently recommended, but the results of this method of treatment are disappointing. While local measures in this disease are of little or no value, brilliant results are often obtained here as in other tuberculous affections by the *early* recognition and removal of the primary focus. If it can be shown by the cystoscope that the disease is limited to the region of one ureteric orifice, and that the urine from the opposite kidney is normal, nephrectomy will often bring about a cure of the bladder lesion.

After nephrectomy, Rovsing recommends the injection into the bladder of a warm solution of carbolic acid, and retaining it for three or four minutes. About 50 cc. of the solution should be employed and the treatment repeated three or four times.

Calculus.

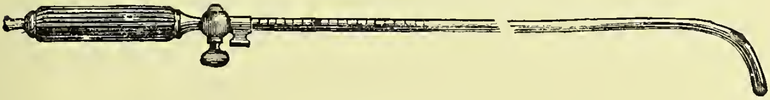
Stone in the bladder is a fairly common disease in certain regions. It seems to be more frequently observed in the tropics, possibly on account of the abundant perspiration and consequent concentration of the urine, also in limestone districts, on account of the greater quantity of mineral salts ingested in the drinking-water. It occurs with greater frequency in childhood and old age than in middle life. It is commoner in men than in women. In an aseptic condition of the urinary passages calculi rarely form in the bladder, but are carried downward from the kidney, lodge in the bladder, and gradually increase in size. If cystitis is present, however, calculi may develop in the bladder. The methods of urinary calculus-formation have been described in the preceding chapter, and will not be repeated here.

Varieties.—Vesical calculi may be composed wholly of *uric acid*, in which case they are round or oval, of a dark-brown color, and with comparatively smooth surface; or of *ammonium urate*, when, as a rule, they are lighter in color; or of *calcium oxalate*, the mulberry calculus, an exceedingly hard, dark-brown or black stone, with a rough, irregular, nodular surface; or of the *phosphates* (a mixture of phosphate of lime and the triple phosphates), these are white and friable, and form in the decomposed urine of cystitis. It frequently happens that a calculus has a nucleus of uric acid or oxalate of lime, while the outer layers are phosphatic. This change in the development of a calculus generally indicates the occurrence of a bladder infection. *Cystine* and *xanthine* calculi are rare.

Symptoms.—The amount of disturbance produced by the presence of a calculus in the bladder varies according to the kind of calculus and the tolerance of the mucous membrane. Thus, a rough heavy stone will, as a rule, produce more irritation than a smooth light one, and a damaged bladder will react more promptly and violently than a healthy organ. Children, as a rule, experience relatively more discomfort from stone than older people, and active individuals more than those who live a sedentary life. Although cystitis is generally present in patients suffering with calculus, it is almost always the result of infection from without if the calculus originally developed in a sterile bladder. It usually follows the passage of some instrument for purposes of diagnosis or treatment, and when it occurs it increases to a marked extent the vesical irritability and other painful symptoms. In children the symptoms of stone in the bladder are frequent and painful micturition, vesical and rectal tenesmus, often with prolapse of the mucous membrane of the bowel. The child is restless, nervous, and irritable, cries with pain at each act of urination and is constantly handling the penis or pulling at the prepuce. In adults there is often a preceding history of gravel and attacks of renal colic. If the calculus forms under sterile conditions of the urinary tract, there may be for a long period no symptoms other than a slight frequency in urination during or following severe physical exertion. As a rule, however, there is vesical irritability, evidenced by an increase of frequency of urination, with slight tenesmus and a pain in the glans penis at the close of the act of micturition. These symptoms are aggravated by bodily exercise and by riding, especially over a rough pavement or road; they are relieved by rest, and seldom appear at night. Later, hæmaturia may occur, generally as a result of some unusual exertion. The general health remains perfect and the urine contains little or no pus. If after the introduction of a sound or searcher, or if from any other cause, the bladder becomes infected, the clinical picture at once changes; the pain is greatly increased in severity, the calls to urinate are more frequent, and the tenesmus is increased. The symptoms now are present at night as well as during the day, the urine contains pus and blood, and there may be fever and sweats. The patient becomes exhausted from lack of sleep owing to the frequent calls to urinate, and loses flesh and strength. If urethral obstruction exists, the disease may extend upward to the kidneys and give rise to septic pyelonephritis, uræmia, and general sepsis.

Diagnosis.—An absolute diagnosis of stone in the bladder can only be made by the cystoscope or by touching the calculus with a metallic sound or searcher. The Thompson searcher (Fig. 248) is the best instrument for this purpose. The patient should lie on a table with the hips raised on a pillow or cushion. The bladder should contain about 6 ounces of sterile fluid. The searcher should be carefully introduced with the beak upward and carried back to the fundus; it should then be turned from side to side, and gently drawn forward and backward until the entire region of the fundus has been thoroughly explored, after which the beak should be turned downward to explore the pocket which often exists just behind the prostate if enlarged. If a calculus lies free in the bladder, contact with the metal searcher will give a distinct click, which can be both felt and heard. It occasionally happens that a

FIG. 248.



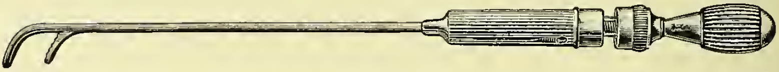
Thompson searcher.

stone is lodged in a diverticulum, in which case the most careful examination with a searcher may fail to detect its presence. In these instances the cystoscope will often reveal the nature of the disease after all other diagnostic means have failed. As in other portions of the urinary tract, the x-rays will often demonstrate the presence of a calculus in the bladder.

Treatment.—Except in cases in which the physical condition of the patient is such as to preclude the possibility of any operative procedure, the indication is in every instance to remove the stone. Several methods are at present in use to accomplish this end, each having its advantages and disadvantages, and each applicable to certain conditions of the patient. These will be considered in the order of their frequency of application.

Litholapaxy, or rapid lithotrity with immediate evacuation of the fragments. This operation consists in crushing the stone by means of a lithotrite (Fig. 249), followed by removal of the fragments with an evacuator (Fig. 250). The patient should be placed on a table with the hips slightly raised; the bladder should be emptied and 6 ounces of warm boric acid solution introduced. The closed lithotrite should then be carefully passed into the bladder and the angle of its beak allowed to rest in the median line upon the floor of the organ near its fundus. The male blade should then be slowly drawn backward while the beak of the instrument is depressed into the most dependent portion of the vesical pouch; the instrument is then closed by pushing the male blade into place. Usually the stone is caught after one or two such attempts; if not, the lithotrite is rotated to one side or the other, and the same procedure repeated after first locating the stone with the closed instrument. When the stone is firmly grasped between the jaws of the lithotrite it is crushed by slowly forcing the blades together with the handle screw. This process is repeated many times until the calculus is reduced to small fragments. The lithotrite is then withdrawn and the evacuating catheter introduced, and after allowing an ounce or two of the fluid to escape, the evacuating syringe, filled with warm boric acid solution, is attached and from 1 to 2 ounces of fluid forced into the bladder and withdrawn by alternate compression and relaxation of the rubber

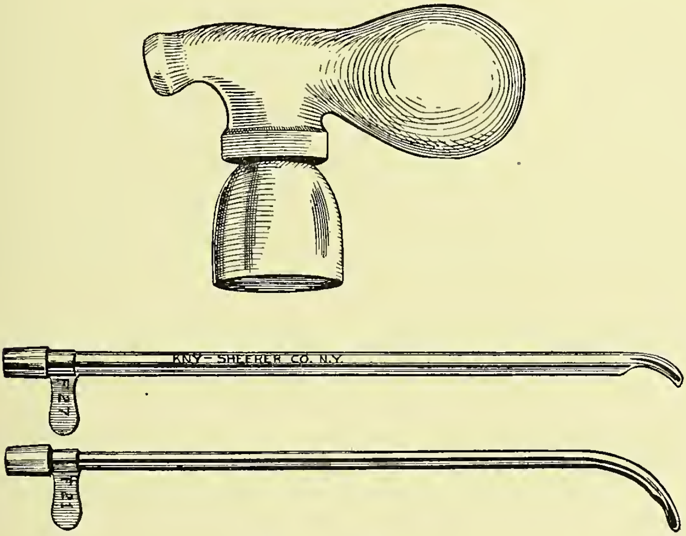
FIG. 249.



Bigelow lithotrite.

bulb. By this means the fragments are aspirated into the glass receptacle at the bottom of the evacuating syringe. The presence of large fragments which cannot be aspirated through the tube is indicated by their clicking against the tube during the evacuating process. When these are present, the lithotrite is again introduced and these fragments further broken up and evacuated. When the bladder is emptied of fragments, it should be thoroughly cleansed by a careful washing with warm boric acid solution and the patient subsequently treated by diuretics, bladder irrigation, and anodynes if pain and cystitis are present.

FIG. 250.

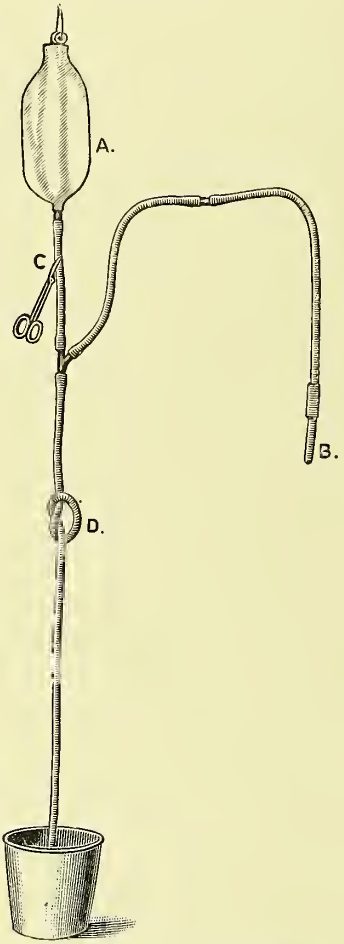


Chismore evacuator.

In this operation care should be taken to avoid injury of the mucous membrane by including it between the blades of the lithotrite and the stone. To prevent this accident, the bladder should be fairly well distended with fluid (not less than 4 ounces), and after the stone is caught the instrument should be freely rotated before crushing. This operation may occasionally be done with cocaine. Chismore and Swinburne have each reported a series of cases where the operation has been performed in this manner and the patients subsequently treated as ambulant cases. In the majority of instances, however, general anæsthesia is to be advised.

Suprapubic Lithotomy.—In this operation the stone is removed through an opening in the summit of the bladder by an extraperitoneal incision just above the pubis. After the usual preparation the bladder is moderately distended with from 6 to 8 ounces of warm boric acid solution, and a vertical incision is made in the median line just above the symphysis pubis. This is carried down between the two recti muscles to the prevesical space, which is freely exposed by lateral retractors. The fold of peritoneum passing from the summit of the bladder to the anterior abdominal wall is pushed upward if it extends into the field of operation, and the bladder-wall exposed by tearing away the loose areolar tissue and veins with the fingers or forceps. Two stout silk sutures are then passed in a vertical direction through the wall of the bladder on either side of the median line, knotted, and held upward by an assistant. The bladder is next opened by a longitudinal incision between these two suture retractors and the cavity explored with the finger, after which the stone is seized and withdrawn with forceps. If the bladder is not infected, an attempt may be made to close the suprapubic wound completely and establish drainage by the perineal route. If this is done, the bladder should be united with two layers of sutures, the first of catgut uniting the mucous membrane, the second of silk uniting the muscular and fibrous coats. If the bladder-wall is thin, a third row of silk sutures may be introduced, infolding the other two. The muscles should next be drawn together with two or three catgut stitches and the skin united in the usual manner, a small gauze drain being left in the lower angle of the wound reaching to the prevesical space, to allow escape of the urine if leakage should occur. If suprapubic

FIG. 251.



Apparatus for siphon drainage of bladder: A, reservoir; B, suprapubic drainage-tube; C, clamp to regulate flow; D, trap which allows intermittent siphonage of bladder. (Dawbarn.)

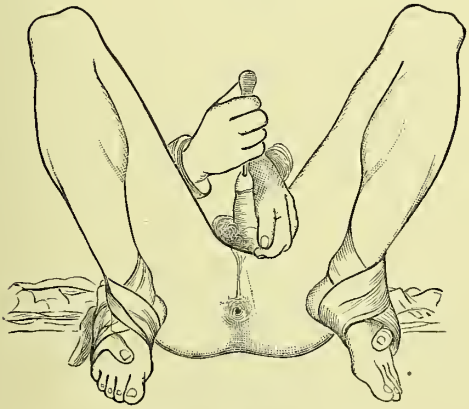
drainage is to be employed, a rubber tube should be introduced, the bladder wound closed tightly about it, and the superficial wound packed with gauze.

The disadvantage of suprapubic drainage is that, unless some apparatus is employed to keep the bladder comparatively empty, the dressings are constantly wet, as well as the patient's person and bedding. This, however, can in large measure be prevented by the use of the siphon drainage (Fig. 251). By allowing the water from the reservoir to flow into the tube very slowly the loop-trap will be filled about once every fifteen or twenty minutes; as this empties itself it sucks the fluid from the bladder.

As soon as the wound begins to granulate the tube may be removed and a smaller one substituted, or it may be left out altogether and the wound allowed to heal. Healing takes place, under favorable conditions, in from three to four weeks.

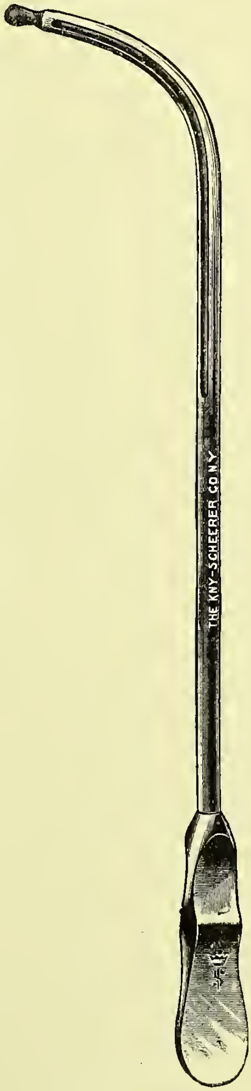
Median Lithotomy.—In this operation the bladder is entered through the deep urethra by a perineal incision. The patient is placed on his back, the buttocks drawn well down to the edge of the table (Fig. 252), and the thighs and knees acutely flexed, and held in this position by two assistants or by the Clover crutch.

FIG. 252.



Lithotomy position. (Roberts.)

FIG. 253.



Grooved staff.

A grooved staff (Fig. 253) is introduced into the urethra and held by an assistant, who also draws up the scrotum, freely exposing the perineum. The surgeon, seated in front of the patient, makes a median longitudinal incision in the perineum, and divides the tissues down to the bulb. The groove of the staff is next felt just below the bulb, and the knife pushed through the urethra into the groove and the urethral tissue incised for a distance of about three-quarters of an inch directly backward toward the prostate. A large probe-director is then passed backward into the bladder and the staff withdrawn. The urethra is next dilated by means of a pair of dressing-forceps passed along the director, and later by the surgeon's forefinger, which finally enters the bladder. When the urethra is sufficiently dilated a pair of lithotomy forceps are introduced and the stone removed. A rubber drainage-tube is passed into the bladder through the perineal opening and held in place by one or two silk sutures. The external wound is packed.

Lateral Lithotomy.—The patient is prepared and placed in the lithotomy position (Fig. 252). The staff is introduced and an oblique incision made beginning at the raphe two inches above the anus and carried downward and slightly outward for three inches, the lower extremity reaching a point midway between the lower margin of the anus and the tuberosity of the ischium. This incision divides the skin and subcutaneous fat. The knife is then plunged boldly inward to the groove of the staff at the upper limit of the incision, and, with the cutting edge turned downward, is pushed through into the bladder. As it is withdrawn the deep cut is enlarged downward, care being taken to avoid wounding the rectum. As soon as the knife is withdrawn the finger is passed into the bladder and the stone felt. A pair of lithotomy forceps are then passed into the bladder and the stone removed. After all hemorrhage is arrested a tube is introduced and the wound packed. The tube may be removed in forty-eight hours. As the wound granulates the urine gradually begins to pass by the urethra.

Choice of Operation.—Litholapaxy should be employed in middle-aged individuals in the absence of severe cystitis where no urethral obstruction or prostatic disease is present, and where the stone is of moderate size and not too hard to be easily crushed by the lithotrite. Suprapubic lithotomy should be the operation of choice in young children and old men, especially when prostatic enlargement or stricture is present. It should also be employed if for any reason a rapid operation is essential to success, and in all cases of very large stone.

Median lithotomy is indicated for small and very hard calculi in middle-aged individuals, and when perineal drainage or exploration of the prostatic urethra is desirable. Lateral lithotomy is now rarely employed. It is occasionally indicated in children if for any reason the suprapubic operation seems unadvisable.

Vesical Calculus in the Female.

Vesical calculus in the female is rare on account of the larger size of the urethra, allowing concretions to pass at an early stage in their development. When present they are frequently phosphatic, and occasionally consist of a deposit of phosphatic salts around some foreign body previously introduced through the urethra. Small calculi may be removed by forceps through the urethra, which can easily be dilated to the size of the forefinger; larger stones should be crushed or removed by the suprapubic operation.

Tumors of the Bladder.

From the most recent reliable statistics Mandlebaum states that only about 0.7 per cent. of all tumors occur in the urinary bladder. Men are affected far more frequently than women, the proportion being 10 to 1. About 65 per cent. are, or eventually become, malignant. It is an interesting and well-recognized fact that many tumors which are histologically benign appear clinically to be malignant. It has also been observed that certain types of histologically malignant growths persue a remarkably benign course, showing no evidence of cachexia or metastasis even after several local recurrences.

Of the epithelial tumors, papillomata and carcimonata are the commonest, adenomata and cysts are rare.

Of the connective-tissue tumors, fibro-myxomata (polyps), fibromata, angiomata, myomata, and sarcomata are to be considered. Dermoids and chondromata have been observed, but are so rare as to be surgical curiosities.

Papillomata may occur as pedunculated or sessile growths, may be hard or soft, according to the amount of connective tissue which they contain, and may be single or multiple. When the softer tumors are placed in water they are seen to consist of large branching processes which float about, giving rise to the term *villous tumor*.

Fibro-myxomata occur almost exclusively in children, and resemble the more commonly observed nasal polyps.

Carcinomata occur in three varieties—the *epithelioma*, which may so closely resemble the papilloma in its various forms as to be indistinguishable except by the microscope; the *adenocarci-*

noma, and the *fibrous* or *scirrhous* type, the last two commonly have their origin in the prostate.

Sarcoma generally arises in the submucous tissues, may be hard or soft, and generally infiltrates all the tunics of the organ.

The majority of the bladder growths arise from the region of the trigone. This is particularly true of the carcinomata, many of which have their origin in the prostate. In multiple papillomata a secondary growth is often found at a point of contact of the mucous membrane with the primary growth when the viscus is empty.

Symptoms.—The two characteristic symptoms of tumor of the bladder are hæmaturia and vesical irritability. As a rule, in innocent tumors the order of their appearance is, hæmaturia first, frequent and painful micturition later; while in malignant growths the dysuria generally appears first and the hæmaturia at a subsequent period. Unlike hæmaturia of calculous disease, bleeding from tumors generally arises spontaneously, often at night. The hemorrhage is more abundant in the papillomata, and may completely fill the bladder with clots, producing retention and vesical tenesmus to such a degree that suprapubic cystotomy will be immediately necessary. Innocent tumors may exist for years without producing symptoms other than occasional hæmaturia and moderate vesical irritability, and this latter symptom may be absent if the growth is located at a distance from the trigone. Obstruction of a ureter from clogging of its vesical orifice by the growth of a tumor is not infrequent, and results in hydronephrosis. If the growth is situated near the urethral orifice, retention of urine may occur. In malignant growths the symptoms are progressive; the pain is present at first only during micturition, later it becomes continuous; the calls to urinate are increased in frequency, and blood is constantly present in the urine. As the disease progresses vesical tenesmus becomes more marked and rectal pain develops; the urine is expelled by spasmodic effort every few minutes, each act being accompanied by agonizing pain. The patient rapidly emaciates, becomes cachectic, and finally dies of exhaustion, uræmia, or sepsis.

Cystitis generally develops in cases of bladder growth, commonly after an instrumental exploration. This may give rise to such an increase in the vesical irritability as to cause an innocent growth to present symptoms strongly resembling cancer.

Diagnosis.—In the presence of symptoms indicating the possibility of tumor of the bladder, hæmaturia, and vesical irritability, one must consider three probabilities: stone, tuberculosis, and tumor.

In stone the hemorrhage is practically never spontaneous, is rarely profuse, and is generally the result of some unusual bodily motion; the pain is more acute at the end of micturition, and is felt with greatest intensity in the glans penis. The stone can generally be detected by a searcher. The general health may not be impaired. In tuberculosis the cystitis and progressive loss of flesh and strength are the prominent symptoms; hemorrhage is rarely abundant, but is apt to be fairly constant. The demonstration of bacilli in the urine by the microscope or as a result of animal inoculation establishes the diagnosis. If these two diseases can be excluded, vesical hemorrhage and irritability generally mean tumor, especially if the hemorrhage occurs spontaneously and is abundant, and there is no other evidence of bladder or prostatic disease. A searcher may detect the presence of a hard, infiltrating, cancerous tumor, but it rarely enables the surgeon to appreciate the presence of a villous tumor, except by provoking hemorrhage.

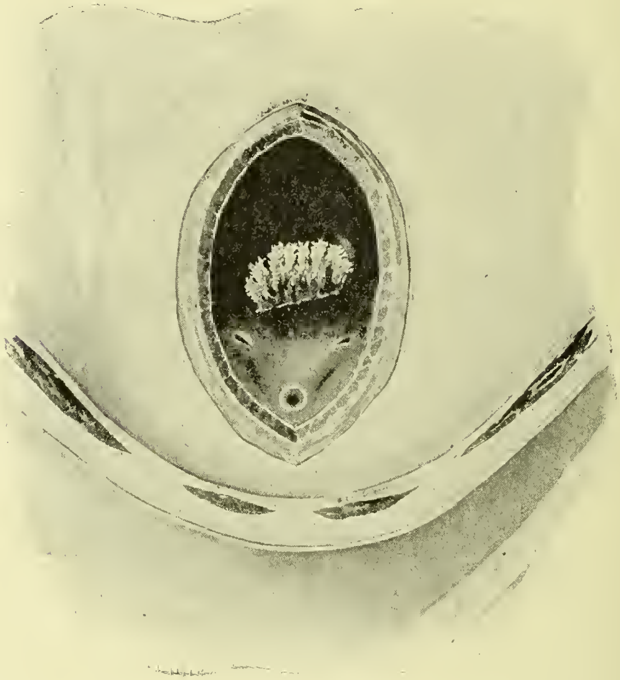
Tumors and large stones may sometimes be palpated by one finger in the rectum or vagina and the fingers of the other hand placed above the pubis. Of all diagnostic means at our disposal, the cystoscope is the most valuable in determining early the presence of tumor of the bladder, and should be employed as soon as a new growth is suspected, before the presence of constant hemorrhage renders its use impossible. By its use, villous tumors may generally be recognized by the presence of the long, slender processes which float about in the fluid, and by the absence of infiltration of the bladder-wall and ulceration. Cancerous growths are generally bulky, nodular, with a surrounding infiltration of the bladder-wall. They often present a ragged, ulcerated surface.

Prognosis.—The chances of a radical and permanent cure in an adult suffering from a tumor of the bladder are not large. Watson has shown that the late results are so unfavorable, both in benign and malignant tumors, that something far more radical in operative technic must be employed if any progress is to be expected.

Treatment.—This consists in the performance of suprapubic cystotomy (see Suprapubic Lithotomy, page 567) for the purposes of exploration. If the tumor is found to be benign, it may be removed by scissors, cutting forceps, or by the hot or cold snare. The surrounding mucous membrane should also be removed and the resulting wound united with previously introduced sutures of chromicized catgut (Figs. 254, 255, 256). If the growth is found to be malignant in character and does not involve the ureteral orifices or trigone, it can be radically removed by excising a portion of the bladder-wall. This is best accomplished by the method suggested by Schmidt. He advises a median suprapubic incision, exposure of the extraperitoneal portion of the bladder, and stripping the peritoneum from the posterior and lateral surfaces. The bladder is then drawn to one side or the other and the diseased area mapped out by intra- and extravesical palpation. The entire diseased area, with a generous margin of healthy bladder-wall, is then excised and the resulting wound closed by two or more layers of sutures.

When the growth involves the ureteric orifice the ureter is divided close to the bladder and, after removal of the diseased area, implanted in the upper angle of the bladder wound (Fig. 257).

Fig. 254.

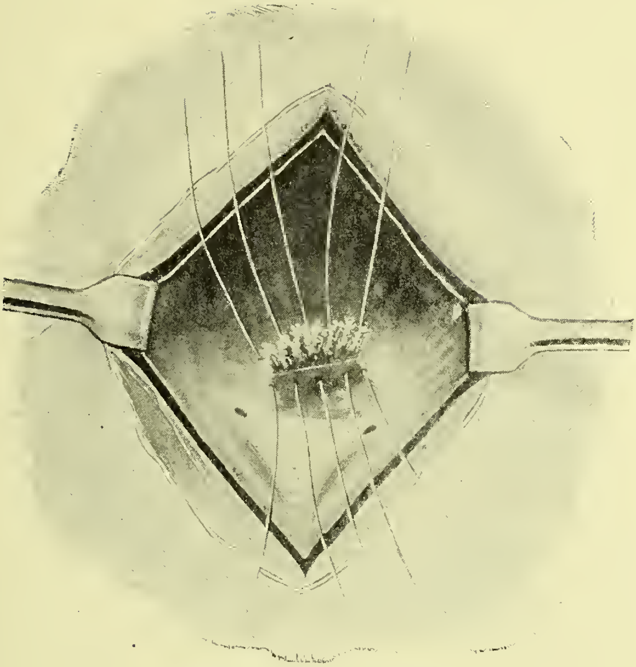


Exposure of papilloma of bladder. (Schmidt.)

Where the disease is more extensive, especially if both ureteral orifices are involved, total cystectomy should be performed with ligation of both ureters near the kidney, and double nephrostomy. In fact, Watson has suggested this operation for all cases of malignant growth of the bladder and for all cases of benign growth which have recurred after primary removal. When this operation has been performed the patients can be kept fairly dry by the use of Watson's lumbar drainage-tube and urinal (Fig. 258).

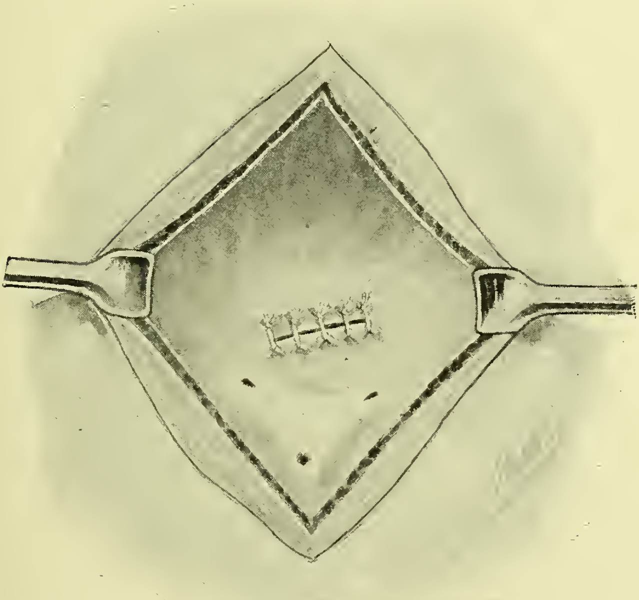
In some cases of malignant growth of the bladder, especially when arising from the prostate, the best approach is gained by a

Fig. 255.



Sutures in place. (Schmidt.)

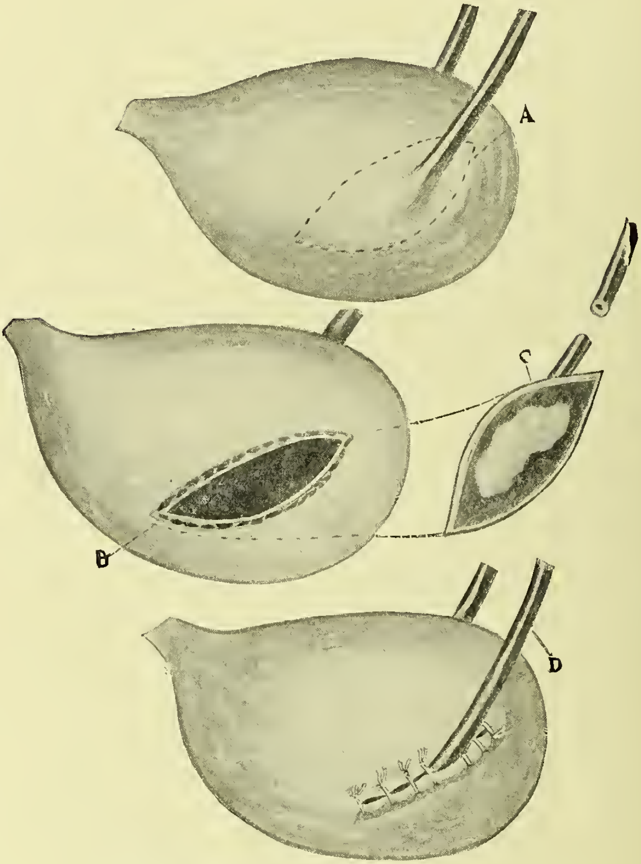
Fig. 256.



Appearance after removal of growth and closure of wound. (Schmidt.)

median intraperitoneal section of the organ, the patient being in the Trendelenburg position. This allows ready access to the prostate and trigone and renders easy the removal of any amount of bladder tissue in this region. When complete removal is impossible, suprapubic or perineal drainage is indicated as a palliative measure.

FIG. 257.



Excision of the bladder for new growth. (Schmidt.)

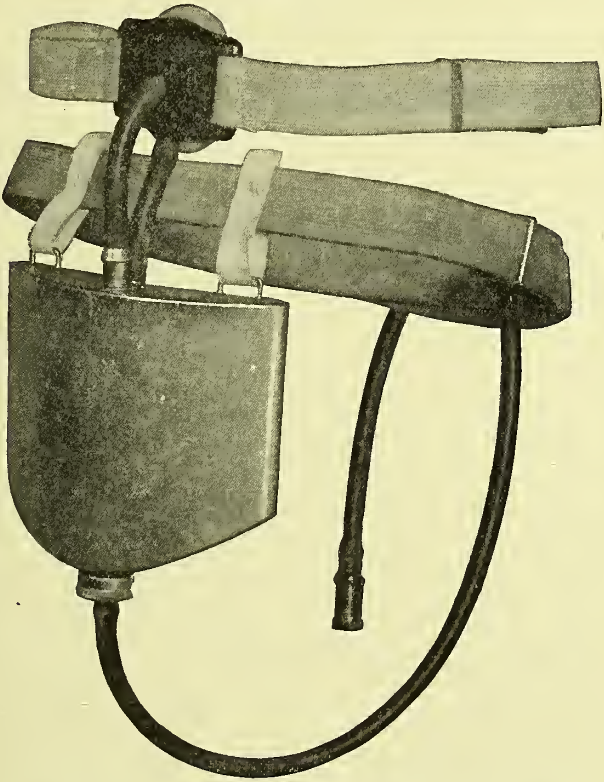
Functional Affections of the Bladder.

Retention of Urine.—While this is often a symptom of some definite lesion, as stricture of the urethra, hypertrophy of the prostate, the impaction of a calculus, periurethral or prostatic abscess, it not infrequently occurs as a functional disorder due to a temporary overstrain of the bladder, to fright, to embarrassment, or to some other purely mental disturbance.

As in other forms of retention, the symptoms are an urgent desire to urinate, pain in the hypogastric region, and the presence of a tumor formed by the distended bladder in the median line just above the pubes.

In the absence of any pathologic obstruction, urinary retention should be relieved by catheterization. It must be remembered, however, that during an acute or chronic retention the bladder is particularly susceptible to infection, and the same precautions should be taken as in the relief of retention due to prostatic hypertrophy, described on page 620.

FIG. 258.



Watson's lumbar drainage apparatus. (Watson and Cunningham.)

Paralysis of the bladder may occur as a result of spinal trauma and other pathologic conditions of the brain and cord. Incomplete paralysis, often resulting in irregular attacks of retention of urine necessitating the use of the catheter, is frequently associated with locomotor ataxia. The symptoms of paralysis of the bladder are retention and overflow. The urine collects in the bladder until it is distended to its fullest capacity, after which it dribbles away through the urethra, producing a condition spoken of as incontinence from overflow. The treatment should be by regular aseptic catheterization.

Atony of the bladder is a condition of paresis of the detrusor muscle, caused generally by obstructive disease of the prostate or urethra, or as a result of temporary overstrain of the bladder from enforced voluntary retention. The bladder-muscle is not paralyzed but weakened. The bladder is able to expel a part of the contained urine, but contraction is incomplete, and a certain amount of urine is constantly present in the viscus which cannot be expelled by voluntary effort. The amount of the *residual urine* gradually increases until there may be great distention and overflow. The treatment should be by regular aseptic catheterization, which will be spoken of more fully under Prostatic Hypertrophy.

Incontinence of urine, due to a lack of voluntary control over the sphincter muscle, may result from some pathologic condition of the spinal cord, from some mechanical injury to the neck of the bladder, or it may be of purely nervous origin. In this condition urine constantly flows from the bladder, keeping the clothing wet and the parts irritated or excoriated. This true incontinence should not be confounded with the false incontinence from overflow seen in overdistention of the bladder.

Nocturnal Incontinence of Children.—This condition, unfortunately quite common among modern children, is a neurosis which is characterized by an increased irritability of the vesical neck, resulting in the spasmodic expulsion of urine during sleep. The condition is a surgical one, only in that it may be the result of some local irritation, as phimosis, calculus, or some irritating lesion of the rectum.

Painful neuroses of the bladder are occasionally encountered in adults, especially in hysteric women. These conditions are characterized by frequent and painful urination, retention or incontinence, the sensation of a foreign body in the urethra or bladder, great bodily weakness following urination, and often an urgent desire to urinate as soon as the patient is placed in a position where urination is impossible. The condition is of purely medical interest, but is mentioned here for the reason that in its graver forms the neurosis often simulates some important surgical lesion. As a rule, these conditions are characterized by the fact that the symptoms are not constant; that they frequently vary from day to day; that polyuria is generally present, and that they are often relieved by suggestive therapeutics.

Treatment.—In all of these nervous disorders of the bladder the treatment should consist in the removal of the cause, if that is possible. If not, regular aseptic catheterization when retention exists, and the wearing of a suitable urinal when incontinence is present.

Pneumaturia.

It occasionally happens that air is passed from the bladder with the urine. This phenomenon is due either to the occurrence of a fistulous tract between the alimentary canal and some part of the urinary tract or, as suggested by Bevan, to infection by some gas-producing organism. In the great majority of cases the cause is a fistula, and is the result of the rupture of an appendicular abscess into the bladder. In other cases it may be due to seminal vesiculitis, to diverticulitis, or to ulceration of the bowel from malignant diseases. Trauma occasionally acts as a causative factor and fistulæ from the kidney pelvis may result from calculus, renal or perirenal suppuration. When large quantities of intestinal matter are discharged into the bladder cystitis may result. The treatment should consist in accurately locating the fistula, and measures to effect extravesical closure.

MALFORMATIONS OF THE URETHRA.

Congenital Absence of the Urethra.

Congenital absence of the urethra and atresia at different points in the canal have occasionally been reported; also congenital diverticula, or urinary pouches. These conditions are exceedingly rare, and for their consideration the reader is referred to treatises upon genito-urinary disease.

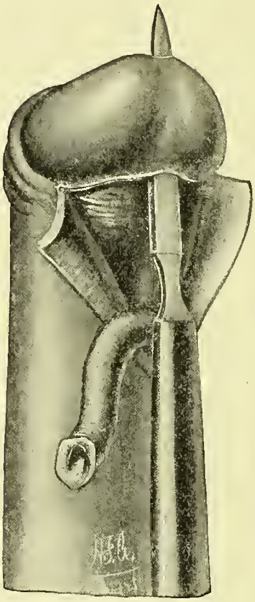
Hypospadias.

Hypospadias is a congenital deformity due to arrest of development which results in a more or less complete absence of the inferior wall of the urethra. Three degrees of this deformity are described: the *glandular,* in which the urethra opens not at the apex of the glans, but on its inferior surface in the space usually occupied by the frenum; the *penoscrotal,* in which the opening is on the under surface of the penis, near its junction with the scrotum; and the *perineal,* in which the external urethral orifice is located in the perineum. In the last variety there are also a cleft of the scrotum, a rudimentary penis, and often a failure of the testicles to descend, creating a deformity sometimes described as *pseudohermaphrodism.*

A moderate degree of hypospadias, in which the opening is situated at or near the glans penis, produces, as a rule, no serious inconvenience. In the severer forms the sexual function is impaired, and urination is sometimes rendered difficult through inability to project the stream from the body.

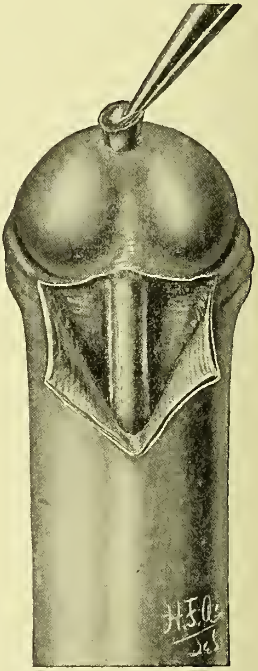
The **treatment** of this deformity is by means of various plastic procedures, each adapted to a certain form of the defect. In the glandular form no treatment is necessary. If the opening is situated between the glans and the scrotum, Carl Beck employs the following method : The urethral orifice and about one inch of the urethra are dissected free from the corpus spongiosum. The glans penis is then tunnelled by means of a sharp, thin-bladed bistoury from the apex backward to the original site of the orifice. Through this the elastic urethra is drawn and retained with fine silk sutures (Figs. 259 and 260). For a description of the plastic operations for the severer forms of the deformity, the reader is referred to works on operative surgery.

FIG. 259.



Beck's operation. (Watson and Cunningham.)

FIG. 260.



Beck's operation, (Watson and Cunningham.)

Epispadias.

Epispadias is a congenital malformation resulting in a more or less complete absence of the superior wall of the urethra. The deformity is rarer than hypospadias. When complete, the condition is associated with exstrophy of the bladder, absence of the symphysis pubis, and a rudimentary penis. Occasionally the external urethral orifice is situated at the root of the penis or on the upper surface of the glans. In these cases the glans or rudimentary penis is cleft or deeply grooved. Some of the incomplete forms may be remedied or improved by plastic operations.

INJURIES AND DISEASES OF THE URETHRA.

Contusions of the Urethra.

Contusions of the urethra may occur as a result of blows or falls upon the penis or perineum. The mucous membrane may be swollen, ecchymosed, and surrounded by a blood-clot giving rise to partial obstruction to the passage of urine. No treatment is required other than that addressed to the external injury.

Wounds of the Urethra.

Wounds of the urethra may occur from stab or gunshot injuries, from glass cuts, and as a result of various other lacerating traumata. Clean-cut longitudinal wounds should be freely exposed and united with fine catgut sutures; ragged, contused, and irregular wounds should be treated upon the principles laid down for the treatment of urethral rupture.

Rupture of the Urethra.

Rupture of the urethra is of fairly frequent occurrence. It is important on account of the fact that, if it is unrecognized or neglected, it is apt to be followed by extravasation, gangrene, sepsis, and death.

The injury occurs with greatest frequency in the perineal region, and is caused by blows, kicks, or falling astride a beam or other hard substance. It may occur in the penile urethra from any injury which forcibly drives the penis upward against the pubic bone. It is rare in the prostatic portion of the canal. As a rule, it is accompanied by more or less contusion of the overlying soft parts, but the injury to the urethra is usually caused by its being pushed violently against the pubic bone. The wound is generally a lacerated one, and may completely divide the canal. When the patient attempts to urinate, the urine is forced out into the surrounding tissues, producing more or less extensive extravasation, which, if unrelieved, results in sloughing of the parts, cellulitis, and abscess.

The **symptoms** of rupture of the urethra are localized pain, hemorrhage, and retention. The pain is moderate in degree at first, but often is greatly increased after efforts at micturition, which give rise to increased hemorrhage and extravasation of urine into the surrounding tissues. Hemorrhage may immediately follow the injury, or it may appear only during efforts at urination. Retention may be complete, or any amount of urine may be passed. Absolute retention generally means extensive laceration or a complete transverse rupture of the canal. Extravasation into the anterior perineal compartment, between the deep perineal fascia and anterior layer of the triangular ligament, gives rise to a perineal swelling which lies between the rami of the pubis and above a transverse line connecting the two tuberosities of the ischium. If the extravasation is large, the tissues of the scrotum are infiltrated and the swelling appears in the abdominal wall above the pubis. If the extravasation occurs between the two layers of the triangular ligament, the deep perineal compartment, it appears as a deep triangular induration which is limited in extent until it ruptures into the ischiorectal fossa or anterior perineal space. Extravasations behind the deep layer of the triangular ligament (from the prostatic urethra) may burrow above the levator ani muscle or rupture downward into the ischiorectal fossa. Abscess, sloughing, and extensive loss of tissue result unless the extravasation is speedily relieved by free incisions.

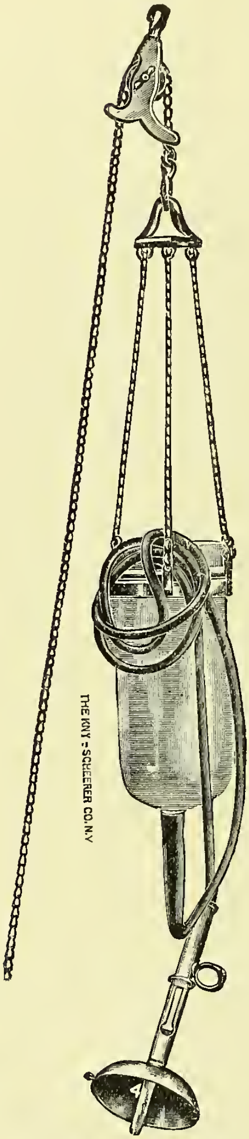
Treatment.—The first indication is to relieve the retention of urine when this is present. This should be accomplished by the introduction of a catheter. It will generally be found that a solid silver instrument or the gum-elastic coudé catheter will be most serviceable; the beak of the instrument should continually hug the roof of the canal during its introduction, as this is the part that is least likely to be injured by the trauma. Prolonged efforts at catheterization should not be made. If the instrument does not readily pass, the retention, if urgent, may be relieved by aspiration while the patient is being prepared for operation. In complete perineal rupture of the urethra an external incision may be made down to the point of rupture and the divided ends of the canal sutured with fine catgut, the wound closed, and a catheter passed to the bladder and tied in. This theoretically ideal method almost never succeeds. The method usually adopted is to remove all bruised and necrotic shreds of tissue, introduce a No. 30 F. perineal drainage-tube into the bladder through the perineal wound, and secure it in place by a suture and packing. As soon as the wound begins to granulate the tube can be removed and full-sized sounds passed every second or third day until the perineal wound has healed. If there has been a complete rupture, or if there is much loss of urethral tissue, sounds should be employed at intervals throughout life. It sometimes happens after severe injuries that the proximal end of the urethra cannot be found in the perineal wound. Under these circumstances retrograde catheterization through a suprapubic opening may be necessary. In severe lacerations of the penile urethra, external perineal urethrotomy with bladder drainage is indicated, with the use of a full-sized rubber catheter passed from the meatus to the perineal wound and retained in place until granulation of the wound is well advanced. This should be followed by the regular use of sounds for a long period.

Acute Urethritis.

Acute urethritis is an inflammation of the urethral mucous membrane, characterized by the presence of a purulent discharge and painful urination. Although acute urethritis may be occasioned by trauma, gout, rheumatism, typhoid fever, and a variety of other less virulent infections, in 99 of every 100 cases the disease is due to infection of the urethral mucous membrane by the gonococcus, and is acquired by sexual contact.

Symptoms.—After a period of incubation which varies from one to fourteen days the patient will experience an itching or burning sensation about the meatus, with slight pain on urination. If examined at this time, the lips of the meatus will be found to be reddened and œdematous, and a drop of cloudy mucus can be expressed from the urethra. These symptoms rapidly increase in severity, the discharge becomes more abundant, and the pain on urination more acute. The penis is swollen, the prepuce becomes œdematous, the glans fiery red and tender to the touch. Erections occur, chiefly at night, and are often exquisitely painful. The discharge becomes thick and creamy, and the pain on urination intense. In uncomplicated and untreated cases the height of the disease is reached about the tenth or twelfth day. From this time it may continue without improvement for from four to six weeks. It then gradually subsides, and, after a number of weeks, the discharge may lose its purulent character and become scanty and watery. In a large number of cases symptoms of *posterior urethritis* appear early in the disease, generally as a result of some unusual bodily exertion, sexual excitement, or alcoholic stimulation. These are frequent micturition, vesical tenesmus, and sometimes the passage of blood with the last drop of urine expressed. Of the other complications which are likely to occur in cases of acute urethritis, epididymitis is the most frequent: cystitis, prostatitis, seminal vesiculitis, pyelitis, gonorrhœal rheumatism, and general sepsis are occasionally encountered, and will be considered in separate sections.

FIG. 261.



Valentine irrigating apparatus.

Diagnosis.—The occurrence of an acute purulent discharge accompanied by painful urination and chordee in a previously healthy individual would be sufficient to render the diagnosis of a gonorrhœal infection *almost* certain. The finding of the gonococcus in the secretion would remove all doubt. The non-gonorrhœal infections of the urethra are, as a rule, much less severe and are short-lived. If the two-glass urine test is applied, the presence of pus in the second glass indicates posterior urethritis.

Prognosis.—It is possible that an untreated case of gonorrhœal urethritis may recover; but recovery under these circumstances must be exceedingly rare, for even under the most approved methods of treatment a fairly large proportion of cases never fully recover. The disease is apt to remain in the glands and follicles of the urethra and prostate, as well as in the ejaculatory ducts and seminal vesicles, for a long period of time. In these situations gonococci develop, and cause a small purulent secretion which from time to time is poured out into the urethral canal and may reinfect its mucous surface, producing the frequent acute attacks which certain individuals experience as a result of coitus, sexual excitement, or the excessive use of alcohol. Under appropriate treatment the disease may be expected to subside and complete recovery to take place in from four to six weeks. Cessation of discharge may often be effected in from three to ten days, but much more treatment is required before the patient can be said to be cured.

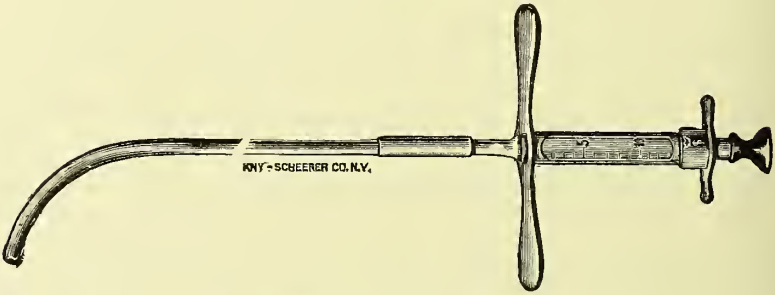
Treatment.—Patients undergoing treatment for an acute urethritis should abstain from all alcoholic drinks, excessive bodily exertion, sexual excitement, and highly seasoned food. They should drink copiously of pure water, lemonade, or milk and vichy. Copaiba, sandal-wood oil, and cubebs, when given in sufficiently large doses, greatly diminish the amount of discharge and ardor urinæ, but do not cure. They are often useful as auxiliary measures when the symptoms are too acute to permit the use of more effective local treatment.

Irrigation of the urethra with mild solutions of mercuric chloride or potassium permanganate has long been a popular method of treating the disease. The urethra should first be cleared of pus by urination, after which from 1 pint to 1 quart of a warm bichloride solution (1 : 30,000) or permanganate (1 : 8000) should be allowed to pass through the anterior urethra by means of the Janet or Valentine irrigating apparatus (Fig. 261). The strength of these solutions may be gradually increased as the symptoms improve. This method, however, has of late been superseded by the use of solutions of the newer silver salts.

Argonin, protargol, argyrol, and novargan have been the ones most frequently employed. Swinburne, who has thoroughly tested all of these agents, recommends argyrol in 10 per cent. solution or novargan in a 2 per cent. strength. These are injected into the urethra after urination, and allowed to remain one minute. By this method early cases often can be aborted, and practically all can be controlled.

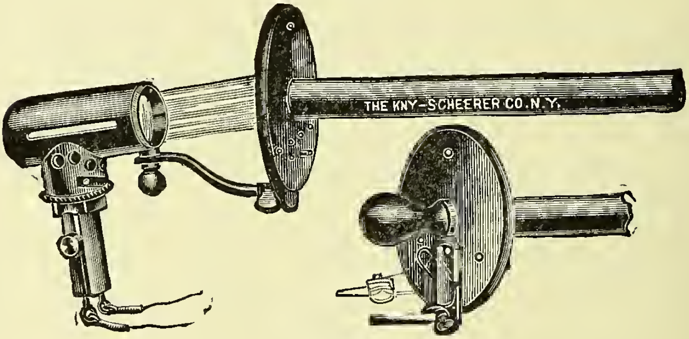
For the treatment of posterior urethritis, the use of these solutions in the deep urethra by means of the Ultzmann or Keyes deep urethral syringe (Fig. 262) will be found effective. The instillations should be made not oftener than once a day; about 10 drops should be used, and the strength of the solution should be somewhat stronger than that used in the anterior portion of the canal. Irrigation of the entire urethra and bladder from the meatus by hydrostatic pressure by means of the Janet or Valentine apparatus is to be recommended when posterior urethritis is present, but only weak solutions of silver nitrate or potassium permanganate should be employed. After the discharge has lost its purulent character, and after the gonococci have disappeared from the thin, watery secretion, irrigations should be suspended and the injection of some astringent solution, as zinc sulphocarbolate, lead acetate, or bismuth suspended in glycerin and water, advised. These injections should be repeated several times a day, always *after* urination. If the discharge does not readily disappear under this treatment, the urethra should be examined by the urethroscope (Fig. 263) for inflamed follicles or granular patches in the anterior urethra, or by the Swinburne posterior urethroscope when the lesions are situated in the deeper portions of the canal. These when present may be treated by direct applications of strong silver nitrate solutions through the endoscopic tube. The use of steel sounds two or three times a week will often be found useful in this stage of the disease.

Fig. 262.



Keyes deep urethral syringe.

Fig. 263.



Otis endoscope.

The patient can be pronounced cured only when no discharge exists, and when the urine, after being retained for six hours, shows no free pus or *tripper faden* containing pus or gonococci.

Chronic Urethritis.

It frequently happens, even after the most careful treatment, that acute urethritis is followed by a chronic condition characterized by the presence of a more or less constant thin mucopurulent discharge (gleet), without pain or other discomfort, and by a frequent return of the acute symptoms of the disease as a result of sexual excitement or alcoholic indulgence. These recurrent acute attacks may closely resemble a fresh infection, and require the same treatment. Frequently there is no visible discharge and the patient believes himself to be well, and the only sign of the disease may be the presence in the urine of small, thread-like bodies (*tripper faden*), which represent the minute purulent secretion which adheres to a granular patch or the contents of an inflamed gland or follicle of the urethral mucous membrane. This condition is frequently associated with stricture, chronic seminal vesiculitis, or follicular prostatitis, and requires long-continued treatment with sounds, deep instillations, and local applications.

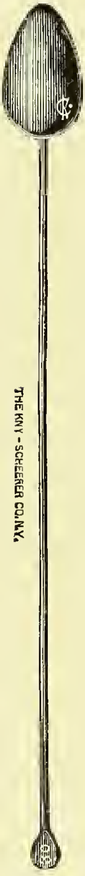
The condition is important chiefly for the reason that the urethral secretions in these chronic cases are often highly contagious, a fact not generally recognized by the profession.

Stricture of the Urethra.

Stricture of the urethra is an abnormal narrowing of the canal due to cicatricial contraction following gonorrhœa, ulceration, periurethral inflammation, or trauma. The cicatrix may completely surround the canal, or it may be limited to a portion only of its circumference. This condition is frequently spoken of as *organic* stricture, to distinguish it from *spasmodic* stricture, a condition which may produce similar symptoms, but is due simply to a reflex contraction of the urethral muscles.

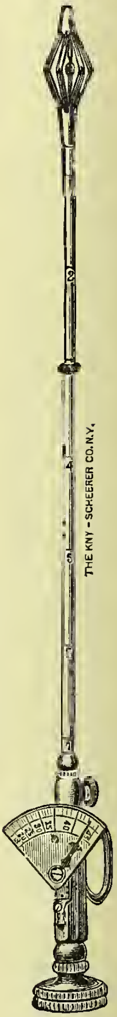
Strictures following gonorrhœa may occur at any point in the urethra anterior to the prostate, but are most frequent in the region of the bulb or near the meatus. They begin as round-cell infiltrations of the mucous membrane and submucous tissue, which are easily detected in the earlier stages by the bulbous bougie (Fig. 264) or urethrameter of Otis (Fig. 265). If subjected to gradual dilatation at this period, they frequently become absorbed and completely disappear. If neglected, they become more fibrous in character and yield less readily to the use of sounds. Strictures occurring in the penile urethra rarely contract to such an extent as to cause retention of urine. In the region of the bulb and membranous urethra, however, they are prone to produce great narrowing of the canal, often converting it into a dense fibrous cord tunnelled only by a narrow, tortuous channel. As a result of the resistance offered by such a stricture to the outward passage of urine the urethra behind the stricture is dilated and the bladder hypertrophied. The mucous follicles and urethral glands behind such a narrowing partake in the general dilatation, and may be converted into minute diverticula, which, if infection be added, may form peri-urethral abscesses which may or may not retain their connection with the urethral canal. When such an abscess breaks externally a urinary fistula may result. If the stricture becomes too narrow to allow the urine to be forced through, or, what is far more common, if a certain amount of inflammation or œdema develops about a narrow but not impermeable stricture, absolute retention of urine results. This quickly causes extreme distention of the bladder and of the urethra behind the strictured area, giving rise to violent expulsive efforts on the part of the patient, which frequently result in rupture of the urethra and extravasation of urine into the tissues of the perineum and scrotum, quickly leading, if not relieved, to gangrene, abscess-formation, and grave sepsis. In narrow strictures of long standing the hypertrophied muscular fibres of the bladder may become separated and the mucous membrane be forced between these muscular bands, forming diverticula or a condition described as a *trabeculated bladder*. If the intravesical pressure is long continued, the ureters and renal pelves may dilate, giving rise to single or double hydronephrosis. If to this condition infection is added, a septic pyelonephritis results.

FIG. 264.



Bulbous bougie.

FIG. 265.



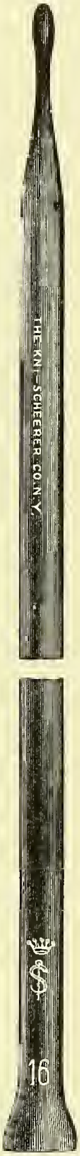
Otis urethrameter.

Symptoms.—In strictures of large calibre there may be no symptoms whatever, or there may be only the symptoms of chronic urethritis due to the presence of granular patches behind the point or points of narrowing. When the stricture becomes sufficiently narrowed to cause obstruction to the natural flow of urine, the calls to urinate may be more frequent, and each act of micturition is accompanied by an unusual and sometimes painful effort. The stream is small, twisted, or scattering, and is expelled with little or no force. Sexual excitement, alcoholic excesses, and severe bodily strain will frequently cause an aggravation of the condition from congestion of the parts, and temporary attacks of partial or complete retention may occur. These are generally relieved by a hot bath and mild cathartic measures. The attacks of retention gradually increase in frequency until finally one occurs which is not relieved by the ordinary methods of treatment; and unless surgical measures can be promptly employed, extravasation of urine takes place, followed by abscess, sloughing, and urinary fistula. Death not infrequently occurs as a result of septic infection following extravasation of urine or from septic pyelonephritis.

Diagnosis.—In a suspected case of stricture the following method may be employed to arrive at a correct diagnosis. The patient is instructed first to pass the urine into two glasses. Pus and shreds in the first glass, the second remaining clear, indicate the presence of a urethritis or an open prostatic abscess. An equal amount of free pus in both glasses indicates cystitis or pyelitis. A large amount of pus in the first and a small amount in the second glass indicate posterior urethritis. If the urine is passed in a fair-sized stream, after disinfection of the meatus and anterior urethra, an Otis urethrameter covered with a freshly boiled rubber cap may be introduced closed to the bulbomembranous junction, opened to No. 30 or 32 F., and slowly withdrawn. If the instrument is arrested at any point, the dilating screw is turned down until the bulb passes the obstruction, then again turned up to the normal size of the canal, and the entire anterior urethra in this manner explored. If the urethra will not admit the urethrameter, it may be explored by means of small bulbous bougies, cutting the meatus, if necessary, for their introduction. After the anterior urethra has been measured, an attempt should be made to explore the deep urethra by introducing the largest sized steel sound which will pass the anterior portion of the canal. If this is arrested, smaller sizes are attempted until one finally passes to the bladder. If the smallest steel sound will not pass, an attempt should be made with the smaller gum elastic or filiform bougies. After the examination has been completed the urethra and bladder should, if possible, be irrigated with a mild solution of silver nitrate (1 : 10,000) or of argyrol.

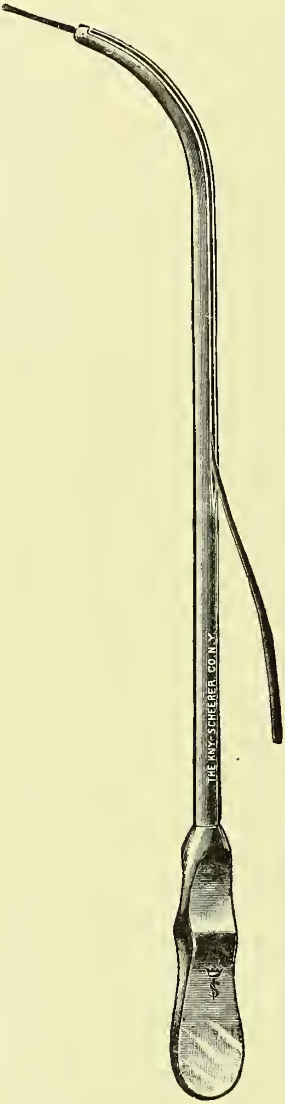
Treatment.—If the surgeon is called upon to relieve an attack of acute retention of urine, during the course of the preliminary examination just described, a small bougie or filiform may be passed to the bladder. This should be tied in and left in place to serve as a guide while the patient is being prepared for operation. If for any reason radical operation is not advisable at that time, the retention will be gradually relieved by urine passing along the side of the bougie. This will be hastened by the use of a hot bath and the ingestion of hot diuretic drinks. Twelve hours later the bougie may be removed and replaced by a larger size, and from this point gradual dilatation may be practised.

Fig. 266.



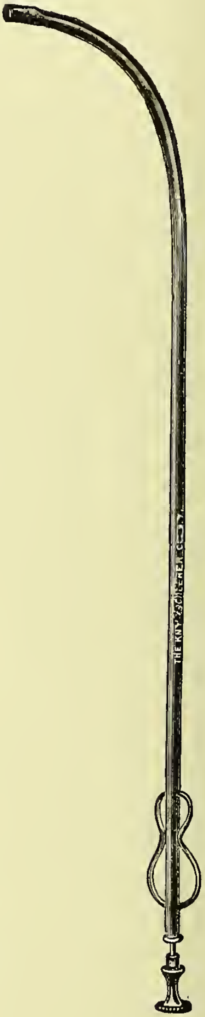
Olive-pointed bougie.

Fig. 267.



Gouley tunnelled sound.

Fig. 268.

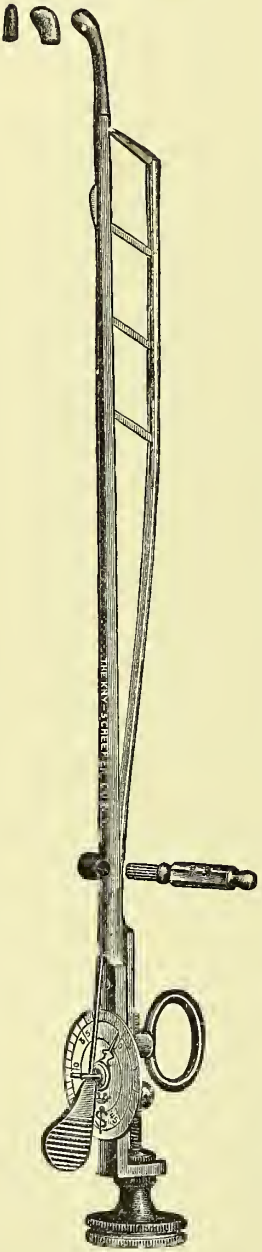


Gouley catheter.

Several sizes of the gum-elastic olive-pointed bougies (Fig. 266) should be introduced each day until the stricture is sufficiently dilated to admit a No. 15 F. steel sound, after which these instruments should be employed. In cases in which the distention of the bladder is great and there is danger of extravasation, the use of the Gouley tunnelled sound (Fig. 267) or catheter (Fig. 268) over the filiform may be necessary to relieve the retention quickly. In case no bougie can be passed, the patient should be etherized and placed in the lithotomy position, and after the usual preparation of the parts a sound should be introduced to the strictured area if this is located in the perineal region, and held firmly against the stricture by an assistant. A longitudinal incision is then made in the median line of the perineum, and the various tissues divided until the urethra is reached; this is then opened on the point of the sound, and the edges of the urethral wound held apart by two silk sutures. An attempt is then made to pass a fine probe director to the bladder. If there are no false passages and the case has not been subjected to harsh instrumentation, the posterior urethral opening can generally be found at the apex of a cone made by drawing outward the urethral margins by the silk sutures. It occasionally happens that a very considerable search is made before finding the posterior opening, and a careful dissection of the perineum may be necessary. When found, the posterior urethra should be dilated with dressing-forceps passed along the groove of the director, or by the finger. A full-sized sound is next passed from the meatus to the bladder to insure the patency of the entire canal, after which a No. 30 or 32 F. rubber perineal drainage-tube should be passed into the bladder through the perineal wound and secured by a single suture. The wound should then be packed around the tube and a T-bandage applied. When the patient is placed in bed the end of the drainage-tube should be connected with one leading to a large bottle or reservoir placed under the bed, and containing a solution of mercuric chloride.

If no posterior opening can be found, two methods are open to the surgeon: One of these is known as Cock's operation, which consists in placing the forefinger of the left hand in the rectum and finding the apex of the prostate, then with the right hand passing a thin-bladed knife through the perineal tissues backward and upward exactly in the median line until the dilated posterior urethral pouch is opened just above the tip of the finger in the rectum. The cicatricial tissue which generally is found to intervene between the anterior and posterior portions of the urethra is then dissected away, a full-sized sound passed from the meatus to the bladder, and the bladder drained with a No. 32 F. rubber tube as described above. The other alternative is to open the bladder from above (suprapubic cystotomy), and to pass a sound, catheter, or bougie outward through the internal urethral orifice

Fig. 269.



Otis-Wyeth urethrotome.

until it bulges the tissues in the perineal wound. It may then be cut down upon and the case treated as in Cock's operation after partial or complete suture of the suprapubic wound. In cases of extreme urgency it may be necessary to relieve the acute retention before the patient can be prepared for operation. Under these circumstances aspiration of the bladder above the pubes may be practised. While this procedure is only for temporary relief, it may be repeated two or three times if necessary before more radical measures are undertaken. The writer occasionally has seen voluntary urination restored after aspiration, presumably from relief of the hyperæmia and œdema about the strictured area. In this operation a small needle should be selected and the point introduced just above the symphysis, the direction being at a right angle to the vertical axis of the body.

In cases of obstinate deep strictures of larger calibre which will not yield to dilatation, or in which the passage of a sound provokes urethral fever or bladder irritability, external perineal urethrotomy with a guide may be practised. This is an operation similar to the procedure just described, but is much simpler for the reason that a grooved staff is introduced first and the cut into the urethra is made upon the staff. After division of all strictured tissue the bladder is drained as described above.

Anterior strictures of the urethra (within five inches of the meatus) may be treated by *internal urethrotomy.* General anæsthesia is not necessary, but is often desirable. If local anæsthesia is employed, about $\frac{1}{2}$ drachm of a 4 per cent. solution of cocaine is introduced into the bulbous urethra by means of a long-pointed syringe, and retained by compressing the lips of the meatus for five minutes. A drop of the same solution is next introduced just below the meatus with a hypodermic syringe. The urethra and glans are then thoroughly cleansed with a solution of mercuric chloride. The meatus, if strictured, is divided downward to the full size of the canal and the other bands accurately located with bulbous bougies. An Otis dilating urethrotome (Fig. 269) is then introduced to such a depth that the blade as it emerges is just behind the stricture. The dilator is opened to the full size of the urethra, putting the stricture on the stretch. The blade is then drawn quickly upward and downward twice, the dilator partly closed, and the urethrotome removed. The hemorrhage is apt to be free for a moment, but soon ceases, after which the canal is irrigated with a hot solution of mercuric chloride (1 : 10,000), a full-sized sound passed, and a dressing of aseptic gauze applied to the penis.

Behind the meatus the cut should always be made in the roof of the canal. Before each urination the dressings should be removed and the meatus bathed with the bichloride solution. After the bladder is emptied the dressing should be reapplied. During the first few days the patient should remain in bed on account of the danger of hemorrhage, which may occur spontaneously, but generally takes place after urination or as a result of an erection. Gently pressing the lips of the meatus together for five minutes and assuming the recumbent posture in bed will serve to check it in the majority of instances.

After all operations for stricture full-sized sounds should be passed, at first every three days, later once a week; and if there is a tendency to recontraction, at least once a month as long as the tendency is manifest.

Urethral Calculus.

Calculi sometimes lodge in the prostatic urethra, behind strictures, or in the fossa navicularis. These occur commonest in children, and may give rise to complete retention of urine. The seat of the impaction is determined by the presence of localized pain and tenderness and by contact with a urethral sound. If they cannot be forced outward or backward, an external perineal urethrotomy should be performed and the stone removed by means of a small scoop or curette.

Tumors of the Urethra.

Primary **epithelioma** of the urethra has been reported, but is exceedingly rare. English, in 1907, was able to collect 45 cases in the literature. It occurs most frequently in the region of the bulb. The disease is rarely recognized early, the first symptoms generally being retention of urine and the presence of a swelling in the perineum. Hemorrhage and a purulent discharge are present in certain cases and sexual irritability may occur.

In the *treatment* of this condition three methods have been employed: Simple excision with cauterization (Koenig), resection of the urethra (Rupprecht), and amputation of the penis (Mikulicz). Although only a few permanent cures have been reported thus far, they are sufficient to encourage surgeons to advise radical operation in all such cases.

Benign growths of the urethra occur more frequently. These are *papillomata*, which may occur just within the meatus, and a *fungoid pedunculated polyp*, sometimes found at or near the bulbo-membranous junction. These growths rarely give rise to marked symptoms unless they reach a size to produce obstruction. Occasionally they cause localized pain on urination and may give rise to a mucous discharge. The diagnosis can only be made by the endoscope. The treatment should be excision by means of scissors or the snare. Some of these tumors are highly vascular, and the bleeding following their removal may be considerable.

CHAPTER XXII.

INJURIES AND DISEASES OF THE PENIS AND SCROTUM.

Contusions.

Contusions of the penis differ in no way from contusions in other superficial regions of the body, unless the injury is such as to cause rupture of the corpus spongiosum or one of the corpora cavernosa. In these cases an extensive hæmatoma may form, which occasionally requires open incision, removal of the clots, and packing. Contusions of the scrotum often result in extensive hæmatomata, either in the cellular tissue or into the cavity of the tunica vaginalis. When in the latter situation the condition is called *hæmatocele.* If of moderate size, these hæmatomata require no treatment other than rest and the application of heat or cold. If large, and especially if they continue to increase in size, they should be treated by free incision, removal of the clots and fluid blood, ligature of any bleeding vessel, and closure with or without drainage.

Wounds of the Penis and Scrotum.

Wounds of the penis and scrotum not involving the urethra or testicles should be treated as wounds in other locations.

Inflammatory Diseases.

Cellulitis.—Cellulitis of the penis or scrotum may follow infected wounds or venereal ulcers. If the infection is mild in character it may resolve under local treatment of acetate of aluminum, or an abscess may form which will require incision and drainage.

If the infection is more virulent, or if the resistance of the individual is lowered, more or less extensive sloughing of the superficial tissues may occur. The treatment should be the same as in other localities.

Herpes Progenitalis.—This is of fairly frequent occurrence in individuals with phimosis, and in others whose habits are not cleanly. It also occurs in neurotic subjects often without local irritation. The disease manifests itself by the appearance of a small group of vesicles just behind the corona, which may also extend to the glans. These soon rupture, leaving small areas of superficial ulceration with a surrounding area of redness. In some instances there are practically no subjective sensations; generally, however, there are itching, burning, and moderate soreness. If a secondary infection occurs, more or less cellulitis may develop with involvement of the inguinal lymph-nodes.

The treatment should consist in circumcision if phimosis is present, cleanliness, and the local use of iodol or aristol powder.

Chancroid or Simple Venereal Ulcer.—This includes all of the venereal sores except the initial lesion of syphilis. The lesion varies from a slightly infected abrasion or herpetic ulceration to the most virulent form of gangrenous cellulitis (*phagedenic chancroid*). The lesions are often multiple and frequently appear at first as one or more small pustules. These may rupture and extend peripherally, and by their coalescence form large sloughing ulcers with irregular undermined edges. The surrounding tissues are reddened and œdematous and the inguinal lymph-nodes enlarge and become tender. The disease is a painful one and often protracted from the suppuration which frequently takes place in the inguinal lymph-nodes (*chancroidal bubo*).

The treatment should consist in early thorough cauterization of the infected ulcer, followed by some antiseptic protective dressing. When suppuration occurs in the inguinal lymph-nodes, they should be removed by operation.

Chancre, or the initial lesion of syphilis, is described on page 61, in the section devoted to Syphilis.

It must be remembered that *mixed venereal ulcers* are frequently observed where the patients have been exposed to both kinds of infection.

In these cases the early appearance of the lesion may be characteristic of herpes or of chancroid, the typical syphilitic induration developing only after the lapse of two or three weeks. One should, therefore, be guarded in prognosis in every case of venereal ulcer until sufficient time has elapsed to allow the syphilitic characteristics to appear.

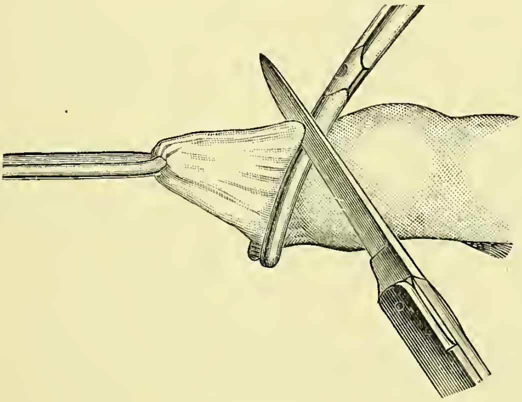
Phimosis.

Phimosis is a stenosis of the preputial orifice preventing retraction of the foreskin. This is generally a congenital affection, but may result from cicatricial narrowing, from the healing of a venereal ulcer, or as a result of trauma. In children there may be adhesions between the glans and prepuce, and a collection of smegma just behind the corona from the retained secretions of the coronal glands. The condition, as a rule, produces no symptoms, but occasionally there is itching or sense of discomfort in the parts, and not infrequently a balanitis is present. In highly nervous individuals the condition may give rise to a more or less constant sexual irritation, evidenced by frequent erections, erotic dreams, and seminal emissions. In younger children, nocturnal incontinence of urine may occur.

Treatment.—In infants the prepuce can usually be stretched sufficiently to allow the glans to be uncovered. If this is impossible, or if, after retraction, too much constriction exists, a simple dorsal incision is generally all that will be required unless the foreskin is abnormally redundant. In older children and adults, and in infants with an excessive length of prepuce, circumcision is to be advised.

Circumcision is performed in the following manner: Either general or local anæsthesia may be employed; the former is generally to be preferred in young children. After careful disinfection of the parts the foreskin is drawn gently and evenly downward, and that part projecting beyond the apex of the glans cut off obliquely from above downward and outward to enlarge the opening (Fig. 270). The few bleeding points are secured, and the parts retracted and united with catgut sutures, after which a dressing of sterile gauze is applied.

Fig. 270.

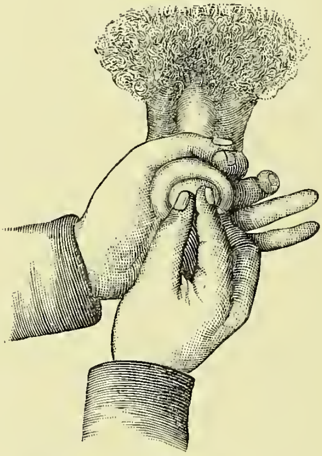


Circumcision.

Paraphimosis.

This condition, which is fairly common, results from forcibly retracting an abnormally narrow prepuce. The constricted part, after it is drawn backward behind the corona, exerts pressure on the veins and causes the glans and adjacent tissues to swell and become markedly œdematous. In extreme cases considerable sloughing may occur. The condition is a painful one, and if neglected, reduction by the ordinary non-operative means becomes impossible. In the early stages the penis should be surrounded with hot gauze compresses, and the parts gently but firmly squeezed with the hand to drive the blood out of the glans and to reduce its size. The œdematous prepuce is then drawn forward with the thumb and index finger of one hand, while the glans is pressed backward, as shown in Fig. 271. When reduction cannot be effected by this plan, an anæsthetic should be administered, the constricting band freely divided, and sometimes a more or less typical circumcision performed.

Fig. 271.



Reduction of paraphimosis. (Phillips.)

Tumors of the Penis and Scrotum.

Papillomata, or warts, are exceedingly common on the glans and prepuce. They appear also on the scrotum. When in the region of the glans penis they are usually associated with phimosis or other conditions producing irritation and an excessive amount of moisture of the parts. *Wart horns* are occasionally observed in this region.

Sebaceous cysts, dermoids, lipomata, and other innocent growths, have been observed in the scrotum.

Epithelioma occurs both on the penis and scrotum. On the penis it frequently develops from a papilloma, more rarely from a chronic ulcer. In the former case the growth may resemble at first a papilloma; later the surrounding tissues become infiltrated, and ulceration occurs. When developing from an ulcer there may be no papillomatous growth, but a progressively infiltrating ulcer, which may later extend to the scrotum. The inguinal lymph-nodes are involved early in the disease. Cancer of the penis seems to be less malignant than in any other parts of the genito-urinary system, and in a considerable number of instances cures have followed radical removal. In fact, Legueu reports the case of an elderly patient with extensive epithelioma where he removed the penis and scrotum, but left enlarged inguinal lymph-nodes owing to his feeble condition. He remained well and without recurrence for four years. The enlarged inguinal nodes gradually diminished in size.

Sarcoma of the penis is rare, and from the 18 reported cases is much more malignant than carcinoma. Endothelioma has been reported in a few instances.

Epithelioma of the scrotum, or chimney-sweeps' cancer, is apparently more frequently observed in England than elsewhere. It begins by what is described as a "soot-wart," which may occur on any part of the scrotum and for a long time remains as an apparently innocent papilloma. Later, ulceration occurs, which gradually spreads and is accompanied by enlarged lymph-nodes in the groin, which in turn break down, leaving extensive ulcerated areas often exposing the iliac vessels. Rarely the primary growth may remain small, while the inguinal metastases assume a large size, giving rise to the belief that the primary growth occurred in that region.

Treatment.—Papillomata of the penis often disappear spontaneously when the conditions which favor their production are removed. Hence circumcision and treatment addressed to chronic urethral discharges may be indicated. Excision of the individual tumors with the knife, scissors, or snare is to be preferred to treatment by caustics. The treatment of other innocent growths in this region is the same as in other parts of the body.

Epithelioma of the penis should be treated by amputation of the organ and removal of the inguinal lymph-nodes.

In the early stage of the disease, when the growth is limited to the glans, the amputation can be made about the middle of the organ. Considerable hemorrhage may follow division of the corpora cavernosa, which is best controlled by buried sutures. The skin is then united to the urethra by a few absorbable sutures. In more advanced cases total amputation should be performed. In this operation the corpora cavernosa should be completely removed, the crura being cut close to the pubic arch; the entire chain of lymph-nodes and surrounding areolar tissue in both inguinal regions dissected out, and the urethra sutured in the perineum. It is occasionally necessary to sacrifice both testicles and the scrotum.

Free excision of soot-warts is to be advised as soon as they appear, for at first they are frequently innocent and show no tendency to recur after removal. When the disease assumes a malignant character it should be extensively removed, sacrificing the testicles if necessary, and removing all the areolar tissue and lymphatics of both inguinal regions.

Varicocele.

Varicocele is a varicose or dilated condition of the veins of the spermatic cord. This disease is of frequent occurrence, being present to some degree in about 10 per cent. of all adult males (Keyes). In the vast majority of cases it occurs on the left side, for the reason that the venous blood-pressure is greatest on this side owing to the greater length of the left spermatic vein and its rectangular implantation into the renal vein. It will be remembered that as the spermatic cord emerges at the external abdominal ring the spermatic veins divide into a large number of trunks, some of which adhere closely to the vas deferens and its artery, while others are more or less separated from the vas by loose areolar tissue. In a condition of varicocele all of these branches become dilated, elongated, and their walls thickened. This produces an increased weight for the dartos to support, and as it gradually yields, the left half of the scrotum with its mass of veins and testicle sags lower and lower until it hangs from one to three inches below its fellow.

The **symptoms** of varicocele are of two kinds, the local and the nervous. Local symptoms may be entirely absent, and the condition may be discovered by accident by the patient, or his attention may first be directed toward it by his medical adviser. When large, the varicocele may cause a sense of weight and sometimes dragging pain in the scrotum and groin, which are relieved on lying down and increased by severe bodily strain. Atrophy of the testicle occasionally occurs. The nervous symptoms are varied in character, but correspond to the group usually present in sexual neurasthenia. Sexual weakness, premature ejaculation, and erotic fancies are the chief complaints.

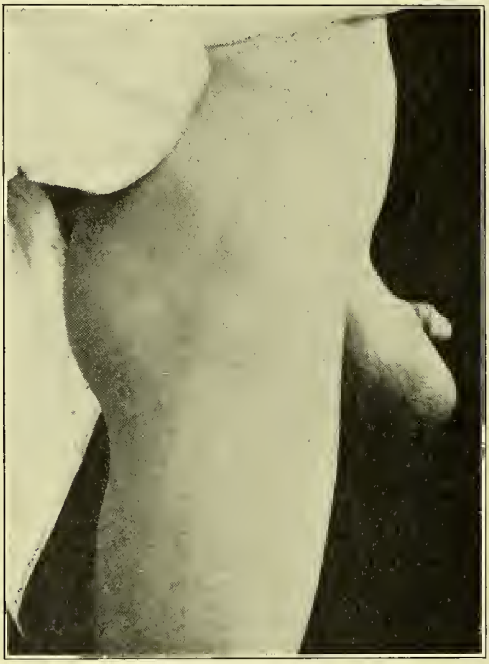
The **diagnosis** of varicocele is not difficult. Enlargement of one-half of the scrotum and the presence of the dilated veins, which give to the examining hand the sensation of a mass of earth worms, are pathognomonic of the condition. The veins are emptied when the patient assumes the recumbent posture, but quickly refill when the erect position is again taken. Pressure over the inguinal ring applied while the patient is on his back and maintained after he rises, will retard but not prevent refill-ing of the veins, unless the pressure is such as to occlude the arteries.

Treatment.—In mild cases without symptoms no treatment is required. If there is a certain amount of pain or dragging sensation, the wearing of a suspensory bandage will often give prompt relief. In the severer cases, in which the symptoms are progressive or are of sufficient moment to justify the use of more radical measures, operation is advisable, which may be performed in the following manner: After the usual preparation of the patient, ether is administered and an incision one inch in length is made over the spermatic cord as it emerges from the external abdominal ring. Through this incision about two inches of the cord are withdrawn, drawing the testicle to the upper part of the scrotal pouch. The various tunics are then carefully divided until the large mass of dilated veins is reached. These are easily separated from the small mass which surrounds the vas deferens, which should not be disturbed. The large mass is drawn outward, freely separated from the rest of the cord, and double ligated with chromicized catgut, one ligature being placed near the external ring and the other just above their junction with the tissues of the epididymis. After the ligatures are applied the intervening mass is cut away and the wound closed without drainage. Many surgeons make the incision through the tissues of the scrotum. There is no advantage in this, and the writer believes there is more risk of infection on account of the corrugated skin and difficulty in keeping the dressings snugly applied.

Hydrocele.

Hydrocele is a collection of fluid in the tunica vaginalis testis. This may be due to an acute inflammation of the epididymis (acute hydrocele), to a chronic inflammatory process of the tunica, to trauma, and to other conditions the nature of which is not well understood. Acute hydrocele almost always accompanies inflammations of the testicle or epididymis. The amount of fluid present under these conditions, however, is usually small, and is rapidly absorbed after the inflammatory process has subsided. In the ordinary forms of chronic hydrocele the cavity of the tunica vaginalis is distended with a clear straw-colored fluid, which gives rise to a pyriform enlargement of one-half of the scrotum, the apex of which is directed upward and extends for a variable distance on the cord (Fig 272). The tumor is smooth, regular in outline, and elastic. If not too tense, fluctuation can generally be detected. There is, as a rule, no subjective symptom other than a feeling of weight or dragging sensation. The testicle is located at the posterior and inferior portion of the sac, and may occasionally be detected by palpation. Unless the walls of the sac are greatly thickened, the tumor is moderately translucent, which serves to distinguish it from solid tumor of the testicle or hæmatocele. The diagnosis can be established by the introduction of a needle and the withdrawal of a straw-colored fluid not spontaneously coagulable, containing albumin and cholesterin crystals.

Fig. 272.

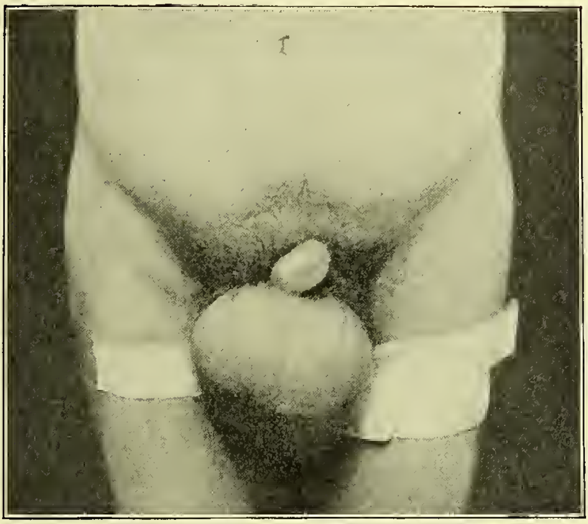


Hydrocele.

Hydrocele of the cord is a circumscribed collection of fluid in some unobliterated portion of the funicular process along the cord. One or more small oval elastic tumors may be seen over the region of the spermatic cord. It sometimes happens that two hydrocele cavities may be connected by a narrow passage, the so-called *bilocular hydroceles.* Double hydrocele (Fig. 273) is rare.

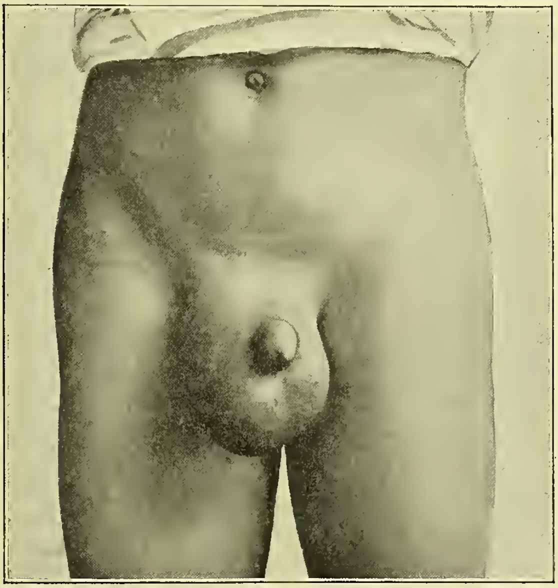
Congenital hydrocele is a collection of fluid in the unclosed funicular process of the peritoneum, and is generally associated with the presence of a congenital hernia. The characteristic sign of this form of hydrocele is that it disappears when the child assumes the recumbent posture, but reappears when he stands erect.

Fig. 273.



Double hydrocele.

Fig. 274.



Hydrocele and inguinal hernia.

Chylous hydrocele is a distention of the tunica vaginalis with a milky fluid resembling chyle. It is due to filariasis.

Treatment.—The palliative treatment of hydrocele consists in tapping the cyst and withdrawing the fluid. To tap a hydrocele properly the scrotum should be disinfected and rendered tense by grasping it firmly with the hand. A sterile trocar is then introduced through the anterior wall, the instrument being directed somewhat upward and backward to avoid wounding the testicle. After the fluid is withdrawn the opening is closed with a bit of sterile cotton and collodion. The fluid slowly returns and the process has to be frequently repeated.

The radical cure of hydrocele is effected by two methods, that by injection of pure carbolic acid into the sac, and the open operation.

If the injection method is to be practised, the scrotum is prepared in the usual manner, and the needle of a hypodermic syringe containing 10 or 15 drops of pure carbolic acid is thrust into the upper part of the sac and held by an assistant. The surgeon then introduces a trocar below and withdraws the fluid. When the sac is emptied, the needle of the syringe still being within the sac, the carbolic acid is injected and evenly distributed by rubbing the walls together. Both openings are then sealed and the patient placed in bed. A certain amount of pain and swelling of the parts occurs during the succeeding forty-eight hours, but this quickly subsides. A cure by this method may be expected in about 90 per cent. of the cases.

Several open operations are practised. The simplest one is to make an incision into the sac, evacuate the fluid, and apply pure carbolic acid to the interior by means of a cotton swab, after which the wound is partly united with sutures and a small gauze or rubber tissue drain left in the cavity for two or three days. Another method is to incise, evacuate the fluid, and pack the cavity with gauze. A third method, and perhaps the surest of all, is to incise the sac freely and then dissect out its parietal layer, arrest bleeding, and partly close the wound, providing drainage by a gauze packing or the introduction of a small folded piece of rubber tissue. Recently several surgeons have advised the following simple procedure, which seems to be satisfactory. After incision through the scrotum, exposing the tunica vaginalis, the latter is opened by a small longitudinal cut and the fluid allowed to escape. The testicle is then drawn outward through the opening in the tunica, which is thereby completely everted, leaving its serous surface in contact with the areolar tissue of the scrotum. The cutaneous wound is then closed without drainage.

All of the open methods require a period of convalescence of from ten days to two weeks.

CHAPTER XXIII.

DISEASES OF THE TESTICLE, SEMINAL VESICLE, AND PROSTATE.

DISEASES OF THE TESTICLE.

Ectopic Testicle.

IMPERFECT descent of the testicle may result in its remaining in the abdominal cavity, near the internal abdominal ring, in the inguinal canal, in or just without the external ring. Under the two last conditions the organ is usually movable, and may often be drawn upward or forced downward at will. In its normal descent the testicle may for some reason escape the scrotal pouch and lie in the subcutaneous tissues of the groin or perineum.

Odiorne and Simmons, from a recent study of 77 cases, conclude that a retained testicle may develop normally until puberty, but if it is not then placed in the scrotum further development is arrested and the organ remains functionless. In its faulty position an undescended testicle may be the seat of frequent traumata, which give rise to inflammatory attacks and fibrous changes.

Such testicles are not infrequently the seat of malignant disease later in life. Undescended testicle is often associated with congenital inguinal hernia.

Treatment.—The treatment of this condition should, as a rule, be deferred until just before puberty, when an attempt may be made to place the organ in the scrotum. In the inguinal, crural, and perineal varieties this is often possible. In the higher varieties of undescended testicle this is impossible, and the testicle should be removed. The operation for undescended testicle should consist in an incision along the inguinal canal extending downward to the scrotum; the testicle and cord should be dissected free from the surrounding tissues, the inguinal canal opened, and gentle traction made to increase the length of the cord. If this is not sufficient to allow the organ to lie easily in the scrotal pouch, the floor of the inguinal canal should be divided and the cord transplanted to allow it to emerge from the abdomen near the pubic spine. This will give an increased length to the cord and allow an inch or more of descent. If the cord is still too short, it may be separated by the finger from its intra-abdominal attachments and the veins divided as suggested by Bevan. A pocket should next be made by separating the tissues of the scrotum, and the testicle and its enveloping tunics placed within it and held by one or two catgut sutures. The inguinal canal should then be repaired as in the Bassini operation for hernia and the wound closed.

Contusions of the Testicle.

Contusions of the testicle are of frequent occurrence and result from a variety of traumata.

The **symptoms** are a severe, sickening pain accompanied often by a grave degree of shock, evidenced by pallor, weakness, cold perspiration, and a rapid, feeble pulse.

The **treatment** should consist in rest and hot fomentations to the injured part. Severe contusions are occasionally followed by inflammation and subsequent atrophy of the organ.

Wounds of the Testicle.

Wounds of the testicle give rise to much the same symptoms as severe contusions, and in these cases the surgical treatment should always be carried out under general anæsthesia on account of the severe shock which frequently accompanies the handling and suturing of this highly sensitive organ.

Wounds of the testicle should be promptly repaired, under the strictest aseptic precautions, for the reason that a failure of union and infection of the parts frequently give rise to *hernia testis*, a condition characterized by protrusions of large masses of convoluted tubules, which form a soft, bleeding, fungating mass requiring castration.

Torsion of the Spermatic Cord.

Torsion of the spermatic cord is a rare condition caused by a twisting of the cord and rotation of the testicle, the etiology of which is not well understood. A fairly large proportion of the cases are associated with imperfect descent of the testicle, and in a few instances persistence of the mesorchium has been noted. Rotation results in a cutting off of the blood supply, which gives rise to hemorrhagic infarction of the organ. In the milder varieties there is pain in the testicle of a sickening character, with nausea and evidences of shock. In the severer forms the vessels may be so strangulated as to give rise to gangrene of the organ. In these cases there is generally to be felt an indurated swelling at the seat of the twist, above the testicle, which is tender to the touch.

If the condition cannot be relieved by manipulation, open operation is to be advised with a view to reducing the displacement or removing the gangrenous testicle.

Acute Epididymitis.

Acute epididymitis is an inflammation of the epididymis, caused in the great majority of cases by extension of a gonorrhœal process from the urethra. This complication is practically always preceded by the occurrence of a posterior urethritis, and the process may extend from the posterior urethra along the ejaculatory ducts and vasa deferentia, or by the lymphatics to the epididymis. It may occur at any period in the disease, but is rare before the second week.

The **symptoms** are pain and tenderness in the region of the testicle, and the rapid formation of an indurated mass occupying the position of the epididymis and partly surrounding the testicle, which, as a rule, is not involved in the process.

The swelling may reach the size of a small orange, is accompanied by redness and œdema of the scrotum, and is exquisitely tender. A certain amount of fluid is frequently present in the cavity of the tunica vaginalis. In certain instances pain and tenderness in the groin over the region of the spermatic cord precede the development of symptoms in the scrotum. In these cases the vas deferens can be felt as a thickened tender cord at or just below the external abdominal ring. The symptoms develop quickly, the scrotal tumor often doubling in size in twenty-four hours. There are fever, headache, malaise, and occasionally chills at the outset. Not infrequently there is marked diminution of the urethral discharge. These symptoms continue without abatement for several days; the pain and tenderness then gradually subside and the swelling slowly disappears. A small hard nodule often persists in the head or tail of the epididymis for months or years, which may completely occlude the lumen of the vas, and, if double, give rise to sterility. Double epididymitis is comparatively rare.

Treatment.—As in other acute and painful inflammatory processes, it is desirable at the outset to empty the bowels and insure absolute rest for the part. Calomel and salts, followed by rest in bed, are therefore to be advised in the beginning of the attack. Elevation of the scrotum by means of a folded towel or a broad strip of adhesive plaster placed beneath the scrotum and extending from one thigh to the other will often relieve the dragging pain, and the application of heat by means of fomentations or flax-seed poultices, will afford additional comfort. In certain cases where the pain is severe and not relieved by these measures, aspiration of the fluid in the cavity of the tunica vaginalis (acute hydrocele) will give relief. In more severe cases Hagner has recommended freely opening the cavity of the tunica vaginalis and making multiple punctures through the fibrous sheath of the inflamed epididymis.

For obvious reasons, treatment by rest in bed is impracticable in many cases. In these the application of 10 per cent. guaiacol ointment and the use of a suspensory bandage will be found beneficial. When the pain is acute and not relieved by the ordinary means, lightly touching the surface of the scrotum with the white-hot cautery point, as recommended by Halsted, will occasionally relieve the pain and enable a previously bedridden patient to be up and about. The use of the *dry poultice* was recommended by the writer in 1891, especially for absorption of the indurations which frequently persist for a long period after the acute symptoms have passed. This dressing consists in a moderately thick layer of cotton applied over the inflamed half of the scrotum. This is covered by a layer of rubber protective tissue so fashioned that it completely encloses the diseased area, with its edges extending on to the healthy skin of the scrotum in a manner partly to overlap but not entirely enclose the healthy side. This is secured by a snugly applied gauze bandage, and the whole held in place by a suspensory. This dressing, by retaining heat and preventing absorption of the moisture abundantly supplied by the sweat-glands, possesses all the advantages of a flax-seed poultice, and, in addition, exerts moderate compression, insures suspension, and allows the patient to be up and about.

Inunctions of mercurial ointment and strapping the testicle are occasionally employed to promote absorption of the exudate in chronic cases. For the sterility caused by the presence of indurated masses in the globus minor of the epididymis Martin recommends epididymo-vasostomy, or anastamosing the vas deferens into one of the tubules of the globus major. Both Martin and Hagner have reported successful cases in which repeated examinations had failed to find motile spermatozoa in the seminal fluid before operation, while after operation they are present in large numbers. In several instances also pregnancy has followed.

Orchitis.

Orchitis is an inflammation of the testicle, caused generally by trauma, occasionally by septic infection of the deep urethra, or metastasis from mumps or other infectious diseases. In these cases the inflammatory process is limited to the tissues of the testicle proper, the epididymis not being involved. The term *orcho-epididymitis* is applied to those inflammations which involve both the testicle and epididymis.

The **symptoms** are pain of a severe and often of a sickening character, extending from the scrotum to the groin and back, swelling, and great tenderness of the organ. If the swelling can be palpated carefully, it will be found to be globular in shape rather than semilunar, as in the case of epididymitis.

Accompanying the local symptoms there are fever, general weakness, and often nausea and vomiting. If the disease is due to infection with pyogenic organisms, the process may go on to suppuration. In the majority of instances, however, resolution takes place, followed in many cases by atrophy of the organ.

The **treatment** is the same as for epididymitis.

Syphilitic Testicle.

Syphilis may affect either the epididymis or the testicle. **Syphilitic epididymitis** is rare; it occurs in the secondary or tertiary stage, and begins usually in the globus major, differing thereby from the gonorrhœal and tuberculous affections, which usually have their origin in the globus minor. The disease spreads to the other portions of the epididymis, and may be accompanied by an effusion of serum into the tunica vaginalis. It is often bilateral. As a rule, there is little or no pain, and the organ is not sensitive to pressure. In **syphilitic orchitis**, which is a more common affection, the disease generally occurs in the late secondary or tertiary stage. It may be diffuse or circumscribed. In the diffuse variety there is an overgrowth of the connective-tissue framework and fibrous tunic, giving rise to a symmetric enlargement of the gland. In the circumscribed variety there is a gummatous infiltration of a part only of the gland, forming an irregular enlargement or globular tumor. The former variety causes a painless enlargement which may persist for years (syphilitic sarcocele), or finally disappear and cause atrophy of the organ; the latter, or gummatous variety if untreated may break down and suppurate.

Diagnosis.—Gonorrhœal epididymitis is easily distinguished from the syphilitic variety by the rapidity of the process, the occurrence of acute pain, and the size of the enlargement. The differential diagnosis between tuberculous and syphilitic epididymitis is more difficult. In the tuberculous affection the process generally begins in the tail of the epididymis; it progresses more slowly than the syphilitic form, it practically always invades the vas deferens, often the seminal vesicle and prostate. The disease frequently follows the gonorrhœal variety. The testicle itself is rarely involved except secondarily. In syphilitic epididymitis the globus major is usually the part first affected. When the entire epididymis is involved, there is nothing in the feeling of the mass to distinguish it from either the tuberculous or chronic gonorrhœal form of the disease. The chief characteristics, however, are that the growth is practically painless, is comparatively insensitive to pressure, and that it never involves the cord, seminal vesicle, or prostate. Syphilitic orchitis is far more common than syphilitic epididymitis. It presents itself as a painless circumscribed or diffuse swelling of the organ, which is prone to gummatous degeneration, softening, and abscess-formation.

Treatment.—Early syphilitic epididymitis requires no treatment other than that addressed to the constitutional condition. In the later affections, potassium iodide should be given in large doses, also mercury in the form of inunction or vapor baths, and locally by means of the constant application of mercurial ointment to the diseased testicle.

In all forms except the chronic fibrous interstitial orchitis the prognosis under intelligent treatment is favorable.

Tuberculous Testicle.

This disease occurs as a chronic, slowly progressing induration and enlargement of the epididymis. In the majority of instances the globus minor is the part first affected, and the early appearance of the disease in this locality may differ in no respect from the chronic enlargements sometimes persisting after a gonorrhœal epididymitis. In fact, tuberculosis is frequently engrafted upon such a focus. As the disease spreads it next involves the cord, then the remaining portions of the epididymis, the seminal vesicle, and prostate, and finally it invades the testicle proper. If the resistance of the individual is considerable and he lives amid favorable hygienic surroundings, the progress is often exceedingly slow, and the primary nodule may remain stationary for months or years. Under less favorable conditions the process may extend rapidly and be associated with evidences of tuberculosis in other organs. In these cases the tuberculous nodules soften early, become adherent to the tissues of the scrotum, and eventually rupture and discharge, leaving one or more sinuses, and occasionally a hernia testis.

Diagnosis.—In the early stages of a tuberculous epididymitis there may be no symptoms other than the presence of a small area of induration in the epididymis. In other cases there are localized pain and discomfort, and a dragging sensation. Tenderness may exist, and occasionally is well marked. When the entire epididymis is involved, it can be felt as a dense nodular semilunar mass moulded over the posterior border of the testicle, and separated from it by a distinct sulcus. The cord can generally be felt to be thickened and nodular, somewhat suggesting the feeling of a string of beads. When the process involves the testicle, this organ enlarges, and later presents on its surface areas of softening which may suppurate and discharge a curdy pus.

For a differential diagnosis between gonorrhœal, tuberculous, and syphilitic disease of the testicle, see page 609.

Treatment.—In the earlier stages these cases are frequently much benefited by a change of air. Living in a mountainous district, especially if surrounded by pines, will often arrest the progress of the disease. When this is impracticable, cod-liver oil, iron, arsenic, and a highly nutritious diet will often prove of benefit. The early removal by surgical means of a localized tuberculous focus when limited to the epididymis or testicle is, however, the best treatment, and should be advised whenever the disease is thus limited.

Undoubtedly castration is the safest and surest means of removing such a focus. The propriety of removing a diseased epididymis only, in a case in which there is no involvement either of the cord or of the testicle, has been largely discussed of late by the profession; and while such a procedure might be advisable under such conditions, the opportunities for carrying out this plan are exceedingly rare, for in the majority of instances when the parts are exposed the disease is found to involve the mediastinum testis or the visceral layer of the tunica vaginalis.

If the cord is extensively involved, and especially if there is evidence of disease of the seminal vesicle, all of these structures should be removed.

Removal of a painful and disorganized testicle in the presence of extensive tuberculous disease elsewhere may be occasionally justifiable for the relief of suffering.

Tumors of the Testicle.

While the subject of tumors of the testicle has been surrounded by much confusion, recent investigations have led to the belief that most of the solid tumors occurring in the testicle arise from embryonic rests which may be of exceedingly complex structure.

Thus we have the slow-growing *teratomata*, which are composed of fibrous tissue, glandular and muscular elements, cartilage, myxomatous material, etc., the so-called *mixed tumors of the testicle*. These, as a rule, are innocent growths, may reach a certain size, and then remain stationary for years. At a later period, however, these tumors may take on a malignant character, grow rapidly, develop metastases, produce cachexia and death. *Carcinoma* of the testicle occurs in both the alveolar type and the diffuse, rapidly growing cellular variety. *Sarcoma* is, perhaps, more frequently encountered than *carcinoma*. It occurs in the slow-growing, hard, fibrous variety, or as a diffuse, rapidly growing, cellular tumor, which closely resembles the soft, cellular carcinomatous growth.

Ewing, who has given much attention to these tumors, is of the opinion that most of them arise from embryonal rests made up of the various tissues found in the innocent teratomata, but that a lawless proliferation occurs in one of the many tissues present, which may grow rapidly and obscure the other elements of the original focus.

This view was suggested by the finding of a small focus of complex teratomatous elements in a tumor which, in other respects, presented the gross and histologic picture of a diffuse cellular carcinoma; and also by the fact that, in malignant degeneration of a teratoma, one can occasionally find both carcinomatous and sarcomatous areas, with evidence of metastasis, both by the bloodvessels and lymphatics.

In a few recorded cases more or less typical *chorion epithelioma* has been reported in a testicular tumor.[1]

A class of tumors has been described by Bland-Sutton and others as arising from the paradidymis. They may appear as single cysts, generally small, occurring near the globus major of the epididymis, and often containing a milky fluid (*spermatoceles*), or as larger masses made up of numerous communicating cysts, sometimes with intracystic growths. These tumors may reach a large size and may compress the testicle. They are commonly spoken of as *adenomata* or as *fibrocystic disease* of the testicle, and, as a rule, are innocent.

Diagnosis.—Subjective symptoms are not marked in tumors of the testicle. Pain is rarely present except in the later stages of the more malignant growths. The presence of an enlargement of the organ and a sense of weight and dragging are all that is complained of by the patient. The cellular carcinomata and sarcomata are, as a rule, easily recognized by their rapid growth and soft or elastic consistence; the fibrosarcomata, by their slow growth, their hardness, and the smooth, regular outline of their surface; the mixed tumors, by their irregular outlines and uneven consistence; the cysts, by their oval shape and their elasticity. In many cases the diagnosis cannot be made clinically.

Prognosis.—In malignant disease of the testicle the prognosis is generally unfavorable, chiefly for the reason that the growth does not give rise, in its early development, to painful symptoms. In the carcinomata and, to a certain extent, in the sarcomata, lymph-node metastasis takes place early and in an inaccessible position;

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[1] For a further description of this rare tumor, the reader is referred to article by Mönckeberg, in Virchow's Archives, Bd. cxc., p. 38.

for Most has shown that the lymphatics from the testicle pass upward with the spermatic vessels and enter nodes surrounding the aorta and vena cava just below the renal vessels. In this locality they are covered by the peritoneum and root of the mesentery, making their surgical removal impracticable. Leguen has recently reported a series of 100 cases of malignant disease of the testicle with 19 cured after three years.

Treatment.—With the exception of the small cysts which appear in the neighborhood of the head of the epididymis, all tumors of the testicle should be removed at the earliest possible moment, for the reason that the majority are genuinely malignant and nearly all have a potential malignancy. Castration with removal of all affected portions of the scrotum and adjacent lymphatics is the operation of choice.

DISEASES OF THE SEMINAL VESICLE.

Seminal Vesiculitis.

Seminal vesiculitis is an inflammation of the seminal vesicle and ampulla of the vas deferens, caused in the majority of instances by the extension upward of a gonorrhœal infection of the urethra through the ejaculatory duct. Other infections of the seminal vesicles are occasionally observed. In these cases the inflammation is generally preceded by a condition of atony of the muscular walls, giving rise to retention of the secretions. This is usually the result of sexual excesses, especially in early life.

The **symptoms** of an acute seminal vesiculitis are often obscure. There may be pain deeply seated in the perineum or rectum, bladder irritability, and sexual disturbances, evidenced by frequent erections and painful ejaculations. In other cases subjective symptoms are absent, and the diagnosis can only be made by feeling on rectal examination a soft, boggy, elongated, tender body in the position of the vesicle. Occasionally in mixed infections an abscess may develop in and about the vesicle, giving rise to severe throbbing pain, fever, chills, and marked tenderness on palpation. Unless relieved surgically, the abscess will generally rupture into the rectum, exceptionally into the bladder, very rarely in both directions, causing a vesicorectal fistula, a condition giving rise to great suffering, and presenting for its successful treatment an extremely difficult surgical problem. In chronic vesiculitis the symptoms are often only those of sexual neurasthenia. The condition is important, however, on account of the frequent reinfections of the urethra which occur during its progress. Fuller, who was the first to study this condition carefully and to appreciate its clinical importance, has demonstrated that many neglected and supposed incurable cases of chronic urethritis may be cured by relief of the vesicular disease.

Treatment.—In the acute stages the pain and perineal discomfort may often be relieved by hot rectal irrigations; gently stripping the vesicle with the finger in the rectum, and emptying it of its contents at regular intervals, and treatment addressed to the urethral infection will generally bring about a cure. In the extremely chronic cases which resist this simple treatment, Fuller recommends exposure of the vesicle, with incision and drainage. By this operation he has succeeded not only in relieving the local symptoms, but on several occasions has been able to rid his patient of a chronic sepsis, evidenced by obstinate and recurring gonorrhœal arthritis.

Tuberculosis of the Seminal Vesicle.

The seminal vesicle is occasionally the seat of a primary tuberculous focus, the infection reaching the part by the blood-current. It may also occur secondarily from extension upward of a tuberculous infection from the testicle, or extension backward of an infection from the prostatic urethra.

Symptoms.—In the earlier stages the process rarely gives rise to subjective sensations. At a later period there may be pain referred to the rectum or neck of the bladder, with frequency of micturition, vesical tenesmus, and sexual disturbances. On examination by rectal palpation the finger detects a firm circumscribed induration of the vesicle clearly contrasting with the soft, boggy feel of the organ when the seat of a gonorrhœal infection.

As in other parts of the genito-urinary tract, a latent tuberculous focus is often awakened into activity by the occurrence of a gonorrhœal infection.

When the disease is clearly limited to the vesicle the **treatment** should be operative, and the disease radically removed. In other cases the treatment should be hygienic and supporting.

DISEASES OF THE PROSTATE GLAND.

Acute Prostatitis.

Acute prostatitis is an inflammation of the prostate gland, caused in the majority of instances by the backward extension of a gonorrhœal process from the urethra, or from an infection conveyed to the organ by the use of urethral instruments. The process varies in intensity from the slight transitory congestion and swelling of the gland which frequently accompanies a posterior urethritis, to an acute suppurative process which may destroy its entire structure. The infection reaches the prostate by direct extension of the inflammatory process from the urethral mucous membrane to the prostatic glands, large numbers of which open upon the floor of the canal. The mucous membrane lining the ducts of these glands becomes thickened, often occluding their orifices and retaining the infected secretions. This gives rise to a perifollicular inflammation, which may cause numerous indurated areas to appear throughout the gland, with more or less congestion and enlargement of the organ. One or more of these may suppurate and discharge into the urethra, or resolution may take place without suppuration. This condition is described as *follicular prostatitis.* In severer cases these follicular indurations may extend rapidly and eventually involve the entire structure of the gland, which becomes greatly enlarged, hot, and tender. One or more foci of suppuration may appear, which usually coalesce, forming a single large abscess cavity. To this condition the terms *diffuse* and *suppurative prostatitis* have been applied.

Diagnosis.—In the acute form of the disease the process is preceded by symptoms of a posterior urethritis : frequent and painful micturition, vesical tenesmus, and pyuria. To these symptoms there are added a slight elevation of temperature and constant pain in the rectum and perineum. In severer cases there may be chills, high fever, and retention of urine from pressure of the swollen gland. Rectal examination is always necessary to establish the diagnosis, as all of the preceding symptoms may be present under other conditions. In the acute follicular variety of the disease the examining finger will feel the prostate somewhat swollen and tender, and studded with several small oval areas of induration. In the diffuse form the gland is symmetrically enlarged, sometimes to the size of a large orange, almost completely filling the pelvic cavity. It is hot, indurated, pulsating, and exceedingly tender. In the acute congestions which sometimes accompany a posterior urethritis there is also considerable swelling, but less tenderness on pressure, and the gland feels elastic rather than densely indurated.

When suppuration occurs there is often retention of urine. There may be chills, throbbing pain, and increased fever ; but these are not constant, as large abscesses are not infrequently encountered in individuals without fever or other constitutional evidences of suppuration. There is generally, however, a marked leucocytosis. Fluctuation may occasionally be detected by rectal palpation. In some cases in which the abscess is small its seat can often be located by feeling an area of increased tenderness, and induration in some part of the gland. In untreated cases, rupture of the abscess generally takes place into the urethra, either spontaneously or as a result of the passage of an instrument for relief of the retention, and in the majority of instances is followed by recovery. Rupture into the rectum is less frequent, and recovery is slower and less certain. Rupture into the ischiorectal fossa and eventually into the perineal region is exceedingly rare. If the abscess ruptures posteriorly, the pus may burrow extensively beneath the rectovesical fascia, giving rise to an extensive pelvic abscess and symptoms of grave sepsis. It occasionally happens that rupture takes place both into the urethra and rectum, creating a recto-urethral fistula, which occasions great suffering and is repaired with difficulty.

The deep pelvic lymph-nodes may very rarely suppurate as a result of infection carried to them from an abscess of the prostate gland. In these cases there are evidences of grave sepsis, which do not disappear after evacuation of the prostatic focus. A continued leucocytosis, indefinite pain and discomfort in the lower part of the abdomen and in the rectum, are the only symptoms. The abscess thus formed may eventually point toward the posterior rectal wall.

Treatment.—In the early stages of the disease the patient should remain in bed and the bowels be freely moved by calomel and salines. Hot rectal irrigation by means of the Kemp tube should be practised every five or six hours, and suppositories of opium or morphine and belladonna administered if the vesical tenderness and pain are severe. In the follicular form of the disease measures should also be employed to allay the posterior urethritis, as deep injections of protargol or silver nitrate and irrigations with mild solutions of potassium permanganate. In the majority of instances under this method of treatment resolution will occur and suppuration be avoided. Relief of pain and a lowering of the temperature do not, however, necessarily mean that suppuration has not taken place. When these occur without diminution in the size of the glandular swelling, and when there is a marked leucocytosis, an abscess is probably present, and should be sought for by an exploratory operation and drained through the perineum. Alexander advises the performance of an external urethrotomy, introducing the finger into the posterior urethra and rupturing the abscess into the canal by digital pressure. The author's plan is to expose the prostate by a perineal incision, as in the operation for prostatectomy; locate the pus by an exploring needle, then incise, and drain with a soft-rubber tube. It is occasionally necessary to open both lateral lobes in this manner.

Chronic Prostatitis.

Chronic prostatitis is a condition frequently following the acute form of the disease, or occurring during the course of a protracted posterior urethral inflammation. In the first class there may be an open cavity resulting from the rupture of a large abscess, which fills up from time to time, causing subacute symptoms, and then ruptures and remains quiescent for a long period. The cavity may contain a calculus, or its interior may be incrusted by phosphatic salts. In the follicular variety, which is usually gonorrhœal in origin, there may be infection of one or more follicles, which are not occluded, but which furnish a secretion constantly reinfecting the urethral mucous membrane.

The **symptoms** of this condition are extremely variable. Pain, frequency in micturition, vesical and rectal tenesmus, may be present; also an obstinate gleet, with *tripper faden* and free pus in the urine. Bacteriuria may be the only symptom in some cases.

The **treatment** of chronic prostatitis consists in measures to relieve the chronic urethral inflammation upon which it depends, as irrigations, deep instillations of silver nitrate or protargol, together with general and sexual hygiene. Regular massage of the prostate is to be recommended in cases of chronic follicular prostatitis in addition to the above measures.

Tuberculosis of the Prostate.

Tuberculosis of the prostate may occur as a primary disease, but is generally associated with tuberculosis of the testicles, seminal vesicles, or bladder.

The **symptoms** are those of prostatic and bladder irritation, generally progressive in character, and not dependent upon previous urethral disease.

The **treatment** is unsatisfactory, as palliative measures only can be adopted in the majority of instances. If, however, it can be demonstrated that a primary focus exists in the prostate, prostatectomy is indicated.

Prostatic Calculi.

Calculi occasionally develop in the crypts of the prostate gland, and are caused by calcification of the corpora amylacea. They are small oval bodies of a light-yellow or brown color, and are generally highly polished.

Their presence in the prostate may cause no disturbance. If the cavities which contain them become infected, suppuration may occur, giving rise to symptoms of acute prostatitis. They are occasionally discharged by way of the urethra or may become lodged behind a stricture and give rise to retention. They should be removed surgically.

Senile Hypertrophy of the Prostate.

Enlargement of the prostate gland occurs in about one-third of all men after fifty. In a small number of these the enlargement is of such a character as to interfere with the function of urination. The causes of prostatic overgrowth are not well understood, but it is probable that the chronic congestion which accompanies sexual abuses in early life and the inflammatory changes which occur in the gland as a result of early gonorrhœal infection play some part in its production.

Any or all of the anatomic structures which enter into the formation of the organ may partake in the process; thus we may have a general hypertrophy of the fibrous and muscular framework of the gland, giving rise to a symmetric enlargement of the organ, or a localized hypertrophy of these structures, resulting in a unilateral enlargement or outgrowth. Distinctly circumscribed tumors are present in more than half the cases, which may be made up of the glandular elements (pure adenomata), or of the muscular and fibrous structures (fibromyomata), similar to those observed in the uterus.

Symmetric enlargements produce, as a rule, less interference with urination than unilateral hypertrophies or irregular outgrowths. One of the commonest locations of the affection is in that portion of the gland lying between the ejaculatory ducts and base of the bladder, which when enlarged creates the so-called third lobe, which not infrequently projects into the cavity of the bladder, elevates the urethral orifice, and sometimes acts as a ball valve, preventing the expulsion of urine but in no way interfering with the passage of a catheter into the bladder.

When the character of the enlargement is such as to cause obstruction to the outward flow of urine, there occurs a compensatory hypertrophy of the muscular walls of the bladder. The thickened muscular fibres are later separated by distention of the viscus, and a prolapse of the mucous membrane occurs between the separated fasciculi, giving rise to a condition described as a *trabeculated bladder*. If the urethral obstruction is progressive, the urine is expelled with more and more difficulty, a condition of *atony* gradually ensues, and a large amount of urine is habitually retained in the bladder which cannot be expelled by voluntary effort. The bladder then distends, often to an enormous size, the ureters dilate, and a condition of single or double hydronephrosis may result.

In practically all cases of obstructive prostatic hypertrophy infection is at some time added by the passage of an instrument for purposes of diagnosis or treatment. If this occurs at an early period, before the obstruction is well marked, the resulting inflammatory process may be limited to the deep urethra or bladder. If the obstruction is considerable and there is much residual urine, the infection generally spreads rapidly to the kidneys, giving rise to a septic pyelonephritis which may prove fatal in a few days or weeks.

Symptoms.—These occur very gradually, and rarely attract the attention of the patient until they have existed for some time. There is a slight frequency in urination, especially at night. With this there is often noticed a slight diminution in the force of the stream and some delay in starting the flow.

The symptoms gradually increase in severity. The calls to urinate are more frequent and urgent, there may be some pain at the close of the act, and there is a feeling of weight in the lower abdomen and perineum. Considerable variation exists in the severity of the symptoms, due to the presence or absence of congestion of the prostate, which temporarily increases the obstruction and irritability. Attacks of temporary retention are of frequent occurrence and may cause great suffering. While the bladder remains free from infection the urine will be clear, and the patient may continue in excellent health, although his rest may be broken by frequent calls to urinate, and he may suffer considerable pain at each act of micturition. If, however, an unclean instrument is for any reason passed into the bladder, the entire clinical picture may suddenly change. Urination becomes much more frequent; extreme urgency and vesical tenesmus are added, fever appears, and the patient is prostrated. The urine becomes cloudy, alkaline in reaction, contains pus and often albumin and casts. Chills and sweats may occur; or the patient may gradually sink into a condition of uræmia and general septic intoxication, ending fatally in from one to two weeks from the date of infection. If the infection is limited to the bladder or prostate, the symptoms of uræmia and general sepsis may be absent, and those of acute prostatitis or cystitis may occur.

In many of these cases which are not carefully observed the diagnosis of malaria or typhoid fever is honestly made by those in attendance.

Diagnosis.—This is established by examination of the gland by rectal palpation, by measuring the length of the urethra, and by ascertaining the presence of residual urine in the bladder.

In the majority of cases of enlargement of the prostate the examining finger will easily detect it. The patient should be examined standing with his trunk flexed at a right angle with his thighs, the hands resting upon the seat of a chair or bench. Under normal conditions the forefinger introduced into the rectum easily reaches a point well above the posterior border of the prostate.

It should be remembered that an enlargement of the so-called third lobe projecting into the bladder, capable of producing complete obstruction, may not be felt by rectal palpation.

The urethral length can be measured by introducing a soft-rubber catheter and noting the distance from the meatus at which the urine begins to flow. The length of the normal urethra is about seven inches. In hypertrophy of the prostate it is generally increased. In some cases the distortion of the gland may be such as to cause the prostatic portion of the urethra to remain open, which would lead to error in estimating the urethral length. The term *residual urine* refers to that portion left in the bladder after ordinary voluntary micturition. The amount is easily ascertained by the passage of a catheter immediately after urination and emptying the bladder by pressure above the pubis. In general it may be stated that the amount of residual urine habitually left in the bladder is a reliable index of the functional disturbance caused by the prostatic enlargement.

The presence of any one of the three signs just mentioned, associated with a non-inflammatory irritability of the bladder in a man over fifty, would render the diagnosis of enlarged prostate probable; the occurrence of all three would render it certain.

Treatment.—Enlarged prostates which give rise only to slight vesical irritability without serious obstruction and without residual urine require no treatment. It is wiser also to avoid the introduction of instruments in aged subjects with moderate symptoms who presumably have a certain amount of residual urine, on account of the great danger of infection and its disastrous consequences in those of low vital resistance. In younger and more vigorous subjects, presenting symptoms of prostatic hypertrophy, an examination should be made to determine the presence, and, if present, the amount of residual urine. Such examinations, however, should never be undertaken without explaining the dangers to the patient and without the employment of the strictest aseptic precautions, for it must be remembered that the first introduction of a catheter into the bladder of a subject with chronic obstructive disease of the prostate, and in the presence of any considerable amount of residual urine, is an operation the mortality of which is far greater than that following removal of the appendix.

The patient should be placed in bed, the meatus and glans penis disinfected, and the anterior urethra irrigated with a solution of mercuric chloride (1 : 10,000). The catheter should be freshly boiled, lubricated with sterile white vaselin or lubochondrine, and gently introduced by the surgeon after thorough preparation of his hands.[1] Just before the introduction of the catheter the patient should be instructed to empty the bladder as completely as possible. If more than an ounce of residual urine is found, the case is one requiring treatment.

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[1] It has been our custom at the Roosevelt Hospital for a number of years to insist upon freshly sterilized rubber gloves being used in every catheterization.

Two methods of treatment are open to the patient, the palliative and the radical. The former aims to relieve the painful symptoms by regular catheterism; the latter, to cure the disease by removing the obstruction.

Catheterism is indicated in the great majority of cases in which the amount of residual urine is comparatively small, in which the instrument can be used without undue force, in which it excites no reaction, and in old and enfeebled subjects whose condition is such as to contraindicate operative procedures.

The patient should devote at least a week to the process of beginning his catheter-life. He should remain in bed for two or three days, to avoid any possible exposure and to insure absolute rest. The catheter should invariably be introduced in the manner just indicated and with the precautions stated, the patient being particularly instructed in regard to the care of his hands and the instrument. He should keep a number of catheters on hand, and should discard them as soon as they become brittle or in any way defective. If chronic cystitis exists, a daily irrigation with boric acid solution is to be advised.

The soft-rubber velvet-eyed or coudé catheter is the safest instrument to use, but the gum-elastic is often preferred by patients on account of its stiffness. The one with the coudé point is generally satisfactory. As the object of the catheterism in the beginning is to prevent increase in the residual urine and consequent atony of the bladder, the employment of the instrument once or twice a day will generally be sufficient. When voluntary urination becomes greatly embarrassed and painful, it is better to depend upon the catheter rather than to permit the patient to strain and congest the parts by voluntary efforts. The rule, however, in these cases should be to empty the bladder completely at each catheterization, and to employ it as infrequently as possible. As a rule, great comfort will be experienced by the patient as soon as he becomes well established in his catheter-life. Attacks of bladder infection are, however, almost sure to occur from time to time as a result of some error in technic. After the back-pressure on the ureters and kidneys has been removed by the avoidance of an accumulation of residual urine, such attacks are less dangerous for the reason that the infection generally remains limited to the bladder and posterior urethra, a situation in which it is readily amenable to treatment.

If difficulty is experienced in the passage of the catheter, or in voluntary micturition, the occasional use of a full-sized sound will afford temporary relief. Permanent suprapubic or perineal bladder drainage is occasionally resorted to for relief of pain and retention in patients who are unable to withstand the shock of the more radical procedures.

The *radical treatment* of prostatic hypertrophy is generally indicated when catheterism is impracticable or fails to afford relief, and in younger individuals whose general health is such as to render the risk of operation comparatively slight. It consists in one of two well-recognized operations: the *Bottini procedure*, or deep cauterization of the thickened neck of the bladder, described on page 626; and *prostatectomy*, or removal of a part of the gland by surgical operations either through a suprapubic opening or by the perineal route, also described in the same section.

The advantages of the Bottini operation are that it can be performed under local anæsthesia, is accompanied by comparatively little shock, affords relief in at least 60 per cent. of the cases, and is attended by a death-rate of only 8.2 per cent.

The advantages of prostatectomy are the fact that it is the only procedure which actually removes the cause of the obstruction and gives permanent results; that, with our present improved technic, the mortality has been reduced to a point even below that of the Bottini operation, and that when relief is once obtained, a recurrence of the symptoms is not likely to occur. It must not be forgotten, however, that incontinence of urine may follow the operation, and that a perineal or suprapubic urinary fistula has occasionally remained.

Carcinoma of the Prostate.

Cancer of the prostate, formerly supposed to be an extremely rare disease, is now known to be of fairly frequent occurrence. The investigations of Albarran and Hall and of Young have demonstrated that from 10 to 14 per cent. of all non-inflammatory senile enlargements of the prostate are carcinomatous in character.

While cancer of the prostate may and frequently does begin as a malignant neoplasm, in a large number of instances it is engrafted upon a senile hypertrophy, particularly of the adenomatous type. This is clearly proved by the large number of reported cases where individuals, suffering for years from the characteristic symptoms of senile hypertrophy, are operated upon, and the tissue removed is later found to present the histologic evidences of beginning malignant change. These cases cannot be recognized clinically, as the malignant disease has not advanced to such an extent as to give rise to characteristic symptoms or signs.

The cases which are easily recognized clinically present an entirely different picture. In these the process extends so rapidly to the very abundant lymphatic system of the pelvis that Guyon has suggested the term *prostato-pelvic carcinosis,* and has strongly advised against any attempt at radical operation.

Young believes that there is a stage of the disease between these two extreme types which can be recognized clinically, and in which the disease is still limited to the gland or its immediate vicinity. In these cases he believes that radical removal holds out some hope for permanent cure.

Regarding the clinical course of the disease, it may be said to be comparatively slow, as many cases are on record where it has existed for four or five years, and as this is after its clinical recognition, the actual duration of these cases is undoubtedly much longer.

Symptoms.—The symptoms of cancer of the prostate, in its advanced stages, are characteristic. The occurrence of pain, frequency, hæmaturia, partial obstruction, and the presence of a hard, nodular growth, involving the prostate, base of the bladder, and rectum, will enable the surgeon to diagnosticate the true condition.

In the earlier stages, when surgical intervention alone holds out any hope for permanent relief, local symptoms may be absent, or only those of senile hypertrophy may be present. To the palpating finger the gland feels abnormally hard, and there may be an induration extending upward along the ejaculatory ducts, or, as Young has described it, an indurated plate between the seminal vesicles. In slightly more advanced cases pain over the distribution of the sciatic nerve may be present; also, slight hæmaturia, especially after instrumental exploration, and a nodular feeling of the organ to the palpating finger.

Bone metastasis is quite common. Visceral metastasis and cachexia occur late in the disease.

Prognosis.—Sufficient data are not available to enable one to formulate any definite conclusion regarding the value of the modern radical operation. There seems to be no valid reason, however, for doubting that here, as elsewhere in the body, early and thorough extirpation of the disease may not effect a cure.

Treatment.—When there is reason to believe that carcinoma has been engrafted upon a senile hypertrophy of the prostate, Young advises prostatectomy and the immediate examination by a frozen section of the tissue removed. If the microscope demonstrates the disease, the radical operation should be performed. In other cases, where the characteristic signs of carcinoma are present, radical removal should be undertaken, unless the growth has advanced so far as to render complete removal impossible.

In hopelessly advanced cases perineal or suprapubic drainage will often give a large measure of relief.

Sarcoma of the Prostate.

Sarcoma of the prostate is much rarer than carcinoma, the proportion being about 1 to 4. While in some cases the rapid growth of a soft tumor would suggest the probability of sarcoma, in most instances the disease cannot be distinguished clinically from carcinoma. The prognosis and treatment of this disease should be the same as in carcinoma.

OPERATIONS ON THE GENITAL ORGANS.

Castration.

An incision is made over the upper part of the scrotum in the line of the spermatic cord, including the skin and dartos. The cord and testicle are separated from their bed of areolar tissue and drawn outward through the cutaneous opening. The various tunics are opened over the upper part of the cord and the vessels and vas deferens ligated separately. The cord is then divided and the testicle removed, the scrotum drained through an opening made in the bottom of the sac, and the wound united with silk. If the castration is for malignant or tuberculous disease, the inguinal canal should be opened as in the operation for hernia, the cord followed upward to the internal ring, and drawn downward as far as possible and treated in the same manner. Inguinal or retroperitoneal lymph-node metastases, in cases of malignant disease, should be thoroughly removed.

Epididymectomy.

The testicle is exposed as for castration, the cavity of the tunica vaginalis opened, the epididymis carefully dissected from the testicle and removed with as much of the vas deferens as is diseased. The wound is then closed with a small rubber tissue drain extending to the cavity of the tunica.

Epididymo-vasostomy.

This operation is recommended for the cure of sterility due to inflammatory occlusion of the vas deferens in the globus minor. It can be performed with local anæsthesia. An incision is made through the posterior wall of the scrotum and the tunica vaginalis opened. The vas is next isolated, divided by an oblique incision, and the lumen still further slit up with fine-pointed scissors. The tissue at the head of the epididymis is next grasped by a small mouse-tooth forceps, and a small section removed by curved scissors. If a patent tube is opened, a small amount of yellowish fluid will now appear, which should immediately be examined by the microscope to demonstrate the presence of living spermatozoa. The open proximal portion of the vas is then placed over the opening in the globus major and held by a few fine chromic catgut sutures. In this operation great care should be used not to injure or wound the veins of the cord, on account of the danger of thrombosis, which seriously interferes with prompt recovery. As a rule, the wound is closed without drainage, a suitable dressing applied, which is held in place by a suspensory, and the patient treated as an ambulant case.

Exposure of the Prostate and Seminal Vesicle.

This operation is accomplished best by the Zuckerkandl curved incision, extending across the perineal space from one tuberosity to the other, the summit of the curve being well above the anal orifice. The incision is gradually deepened to the end of the bulb, and the central tendon divided with scissors. Just behind the central tendon another point of attachment will be found between the rectum and the membranous urethra, the *recto-urethral muscle*. This should be divided close to the urethra, which allows the rectum to fall backward into the hollow of the sacrum, and greatly increases the operative space. The prostate is now easily exposed by blunt dissection, and, by carrying the dissection well above the upper border of the prostate, the seminal vesicles can be brought into view. In performing this operation the patient should be in the lithotomy position with the thighs flexed as acutely as possible. A steel sound should be placed in the bladder as a guide and the rectum kept well out of the way by a retractor. Through this incision abscesses of the prostate or vesicle may be opened and drained.

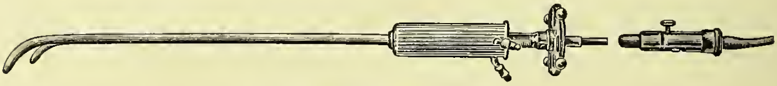
Removal of the Entire Genital Tract.

Removal of the entire genital tract is indicated when there is tuberculous disease of the testicle, vas, and seminal vesicle on one side only, without involvement of the prostate. The patient is placed in the lithotomy position and the seminal vesicle exposed by the Zuckerkandl incision, after which it is carefully separated from the prostate by blunt dissection, care being taken to avoid wounding the urethra and rectum. After the vesicle and the adjacent portion of the vas are dissected free, the position of the patient is changed and the regular operation for castration performed, the cord being followed upward to the brim of the pelvis by free dissection of the structures in the neigborhood of the internal ring. The testicle and vesicle are then grasped by the operator and a sawing motion made, which will quickly separate the deeper portions of the vas from the surrounding tissue, after which the cord is divided at the internal ring and both ends removed. The wounds are then united as described above.

Bottini Operation.

The bladder and urethra should be sterilized as thoroughly as possible, and anæsthetized by a 3 per cent. solution of eucaine; about 5 ounces of boric acid solution should then be injected into the bladder and the Freudenberg-Bottini incisor (Fig. 275) introduced and the beak turned downward. When the beak is firmly pressed against the projecting prostatic mass, the current should be turned on, and a deep incision burned into but not through the hypertrophied mass. Two lateral incisions should then be made in the same manner and the instrument closed and removed. In deciding upon the depth of the incisions one should be guided by the size and shape of the prostatic tumor, determined by previous cystoscopic or rectal examinations. The after-treatment should consist of rest in bed, anodynes, and catheterization when that is necessary.

Fig. 275



Freudenberg-Bottini incisor.

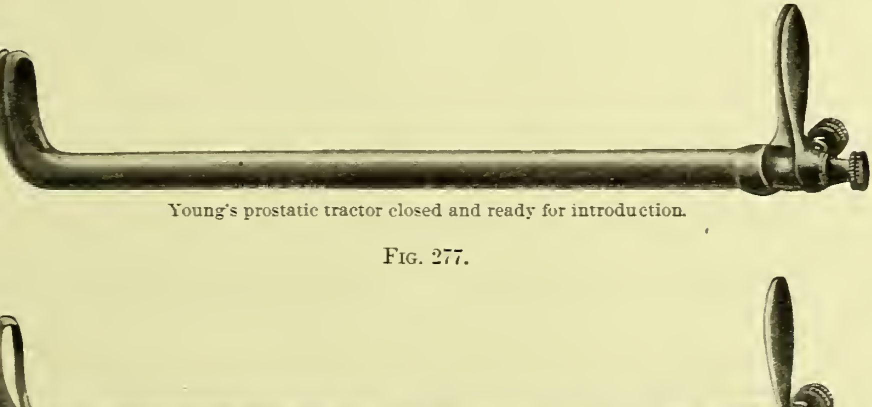
Prostatectomy.

The suprapubic route should be chosen for large intravesical outgrowths; the perineal, for enlargements of the lateral lobes.

Suprapubic prostatectomy, by Fuller's method, is performed as follows: The bladder is opened above the pubis as described on page 567. The prostatic enlargement is appreciated by the examining finger and the bladder-wall incised, preferably by heavy scissors, from the lower margin of the internal urethral orifice, backward in the median line, over the tumor-mass. The forefinger of the right hand is next introduced through this incision, while the closed fist of the left hand makes firm upward pressure against the perineum. This forces the tumor high into the pelvis, where it can generally be enucleated by the finger of the right hand. All obstructing tissue should be removed and the urethra subsequently explored to insure its freedom from projecting masses. A large perineal drainage-tube is next introduced and the bladder irrigated for several minutes with hot salt solution to control the oozing. If the bleeding is not such as to necessitate packing the bladder, the suprapubic wound is partly united with two rows of sutures, and a single medium-sized rubber tube introduced and allowed to remain for three or four days, after which it is removed and the wound closed by tying a previously introduced provisional suture of silk-worm gut, which should include skin, muscle, and bladder-wall. The perineal tube should be allowed to remain in place for a week or ten days.

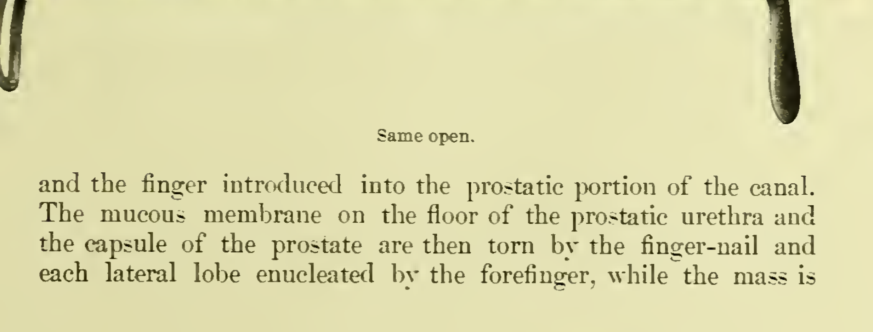
Perineal Prostatectomy.—The simplest method of perineal prostatectomy is Alexander's operation. The patient is placed in the lithotomy position, after a suprapubic cystotomy. The membranous urethra is opened through a generous perineal incision and the finger introduced into the prostatic portion of the canal. The mucous membrane on the floor of the prostatic urethra and the capsule of the prostate are then torn by the finger-nail and each lateral lobe enucleated by the forefinger, while the mass is

FIG. 276.



Young's prostatic tractor closed and ready for introduction.

FIG. 277.

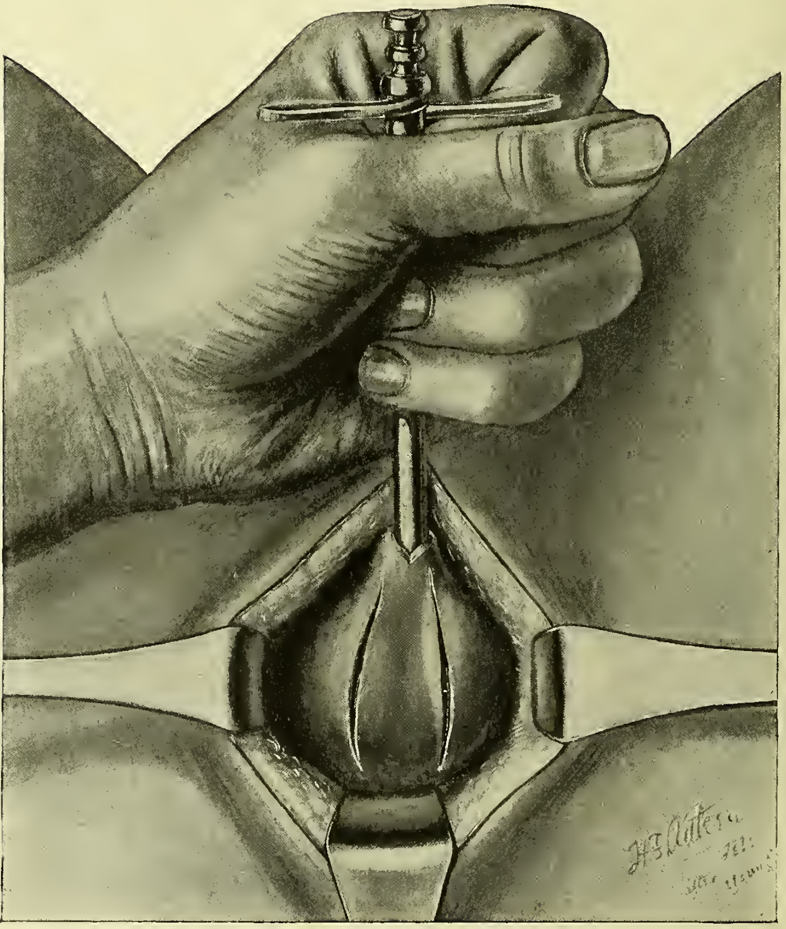


Same open.

forced well downward by the left hand through the suprapubic wound. The subsequent management of the case is the same as by the Fuller method.

Parker Syms draws the prostate well downward in the perineal wound by traction on a rubber ball introduced into the bladder through the urethral wound, and subsequently inflated. This overcomes the necessity of the suprapubic wound and gives excellent control of the gland.

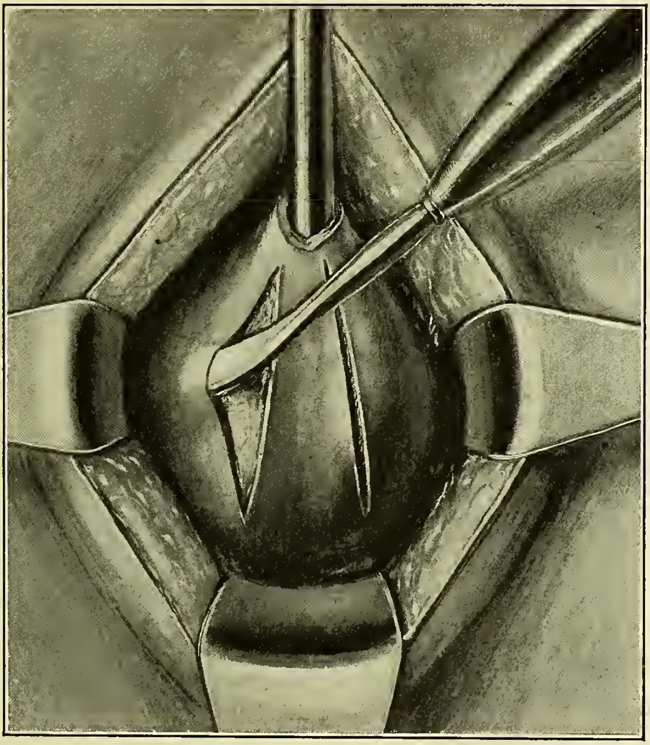
Fig. 278.



Young's technique : prostate brought down and lateral incisions made in capsule. (After Young.)

Hugh Young employes a metal retractor (Fig. 276) which is shaped like a steel sound. This, when introduced into the bladder, is opened (Fig. 277), and with it the prostate often can be drawn downward to the margin of the cutaneous incision. In Young's operation the prostate is exposed as described above, and the retractor introduced through an opening made in the membranous urethra. By drawing the sound well downward and elevating the handle of the retractor the entire posterior surface of the gland can be brought into view. He next makes two slightly diverging longitudinal incisions through the capsule, and by means of a blunt dissector separates the lobe from the capsule, after which removal is effected by the finger or a pair of flat fenestrated lobe forceps (Figs. 278–280).

FIG. 279.

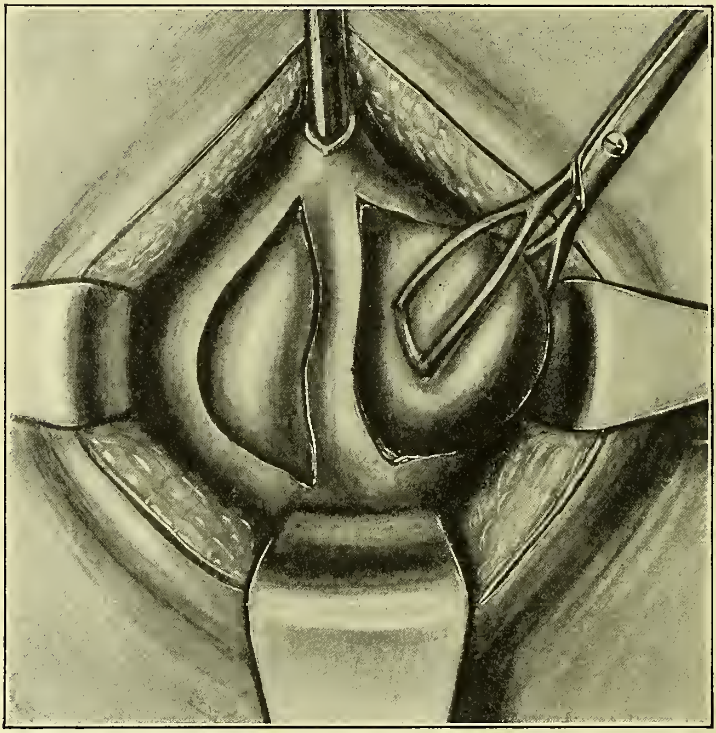


Young's technique: separation of capsule with blunt dissector. (After Young.)

Young states that he is able by this plan to remove practically all enlarged prostates. He recently reported over 100 consecutive cases without a death.

Young's Radical Operation for Carcinoma of the Prostate.—The prostate is exposed as described in the previous section, the membranous urethra cut across, and the retractor introduced into the bladder. The handle is next sharply depressed and the puboprostatic ligaments divided. This enables the operator to draw the prostate well down and often outside of the cutaneous incision. The bladder is then opened from in front, just behind the upper margin of the gland, and the trigone exposed. The incision is next carried downward on either side, and the floor divided just distal to the ureteral orifices. The seminal vesicles are separated from their attachments and the vasa deferentia divided as high up as possible. The entire mass, consisting of the prostate, vesicles and vasa deferentia, is removed, and the large bladder wound reduced in size and united to the distal portion of the urethra by sutures. The levator muscle is drawn together by one or two heavy catgut sutures, a soft-rubber catheter introduced through the urethra to the bladder, the cutaneous wound partly united, and a small gauze drain inserted.

Fig. 280.



Young's technique: withdrawing lateral lobes after being enucleated. (After Young.)

CHAPTER XXIV.

DISEASES OF THE RECTUM.

Congenital Malformations of the Rectum and Anus.

The rectum is formed by the union of the caudal extremity of the primitive hind gut and the proctodæum or cutaneous anal depression. Arrest of development may result in stenosis of the canal, *congenital stricture of the rectum;* in the presence of a membranous septum, *imperforate anus;* or in complete absence of the anal depression, with or without the presence of a blind rectal pouch in the hollow of the sacrum. This pouch when present may or may not retain its original connection with the genito-urinary tract. In the former case the alimentary canal may open into the bladder, urethra, or vagina; in the latter, complete intestinal atresia is present.

Treatment.—Congenital strictures (generally located about one inch above the anus) are to be treated by gradual dilatation. Membranous septa may be perforated and subsequently dilated. Blind rectal pouches should be sought for by perineal incision, and, when found, brought down and sutured to the skin of the perineum when this is possible. When the rectum is too short the opening may be established higher, as in the Kraske resection, or by inguinal colostomy. Communications with the bladder usually close spontaneously after a free exit is given for the intestinal contents.

Wounds of the Rectum.

Injuries to the rectum are rare on account of its protected position. Lacerations about the anus and extending into the bowel may be caused by falls upon pointed objects, by automobile or railway accidents, and by other traumata. The writer has twice observed severe lacerations caused by the horns of an infuriated bull. Such injuries may involve the bladder or urethra, or may extend upward and enter the peritoneal cavity. The rectum not infrequently is injured during surgical operations, as in the removal of the prostate or in perineal cystotomy.

In the treatment of wounds of the rectum the same surgical principles should apply as in other localities. If there is reason to believe that the peritoneal cavity has been entered, laparotomy should be performed and the rectal injury repaired from above. If the wound is confined to the lower portion of the gut, its site should be exposed by a generous incision with partial resection of sacrum, if necessary, and the wound repaired by layer suture. In the extraperitoneal portion of the rectum repair is slower and leakage is apt to occur. Adequate drainage should, therefore, be employed in these cases.

When the wound involves the sphincter muscle great care should be exercised to bring the divided muscular fibres together. If the circular fibres are completely divided, the ends retract, and must be sought for and identified by careful dissection. When found they should be brought together by one or more buried mattress sutures of chromic gut, after which the skin and mucous membrane should be united by silk. When considerable laceration or loss of tissue has occurred, or where the parts are hopelessly infected, the chief effort should be to combat the infection, the repair of the muscle to be undertaken at a later period.

Rupture of the rectum without external injury has been reported in a few instances. Burkhardt collected 14 cases, 13 of which proved fatal. Severe straining at stool is given as the most frequent cause. Where the rupture occurs into the peritoneal cavity the indications are for laparotomy and suture of the bowel wound when this is possible. If local repair is impossible, colostomy should be performed.

Proctitis.

Proctitis is an inflammation of the rectal mucous membrane, caused by extension of an infection from above (colitis) or one introduced from without (gonorrhœa or venereal ulcer); from the presence of a wound or foreign body, a new growth, or ulceration.

The **symptoms** of proctitis are pain, rectal tenesmus, and the frequent passage of stools containing blood and mucus.

The **treatment** should consist in removal of the cause, rest, rectal irrigation, and the use of suppositories of opium to control the pain and tenesmus. Hot sitz baths and fomentations to the anal region often afford marked relief. In the *chronic* cases injections of a solution of glycerite of tannin (1 : 20) will be of value in lessening the mucous secretion.

Periproctitis.

Periproctitis, or *ischiorectal abscess*, is a septic inflammation of the cellular tissue in the ischiorectal fossa, caused by infection from the bowel by perforations of the mucous membrane from fish-bones or other foreign bodies, from ulcerations, and from follicular abscesses; from infections from the genito-urinary passages, as extravasations of urine, peri-urethral abscess or prostatitis; or from infections from without, the result of wounds or severe contusions.

The **symptoms** of ischiorectal suppuration are pain, and tenderness in the neighborhood of the anus, with fever and general malaise. On palpation an indurated area can be felt on one side of the rectum, and the extent of the mass may generally be appreciated by the finger introduced within the bowel. Redness, swelling, œdema of the skin, and fluctuation appear later, and spontaneous rupture may occur. Periprostatic abscess, and occasionally deep-seated suppuration from infection of the lymph-nodes accompanying the internal iliac veins, may rupture through the pelvic diaphragm and give rise to ischiorectal suppuration. In these cases drainage is imperfect even after free evacuation of the ischiorectal focus, and symptoms of absorption continue until the pockets above the levator ani muscle are thoroughly drained.

Treatment.—Early incision and drainage constitute the only treatment of this condition. As the areolar tissue of the ischiorectal fossa is loose and easily broken down, extensive burrowing of pus takes place, requiring large incisions frequently on both sides of the rectum; and in chronic, long-standing cases the deepest recesses of the space should be freely exposed and packed. As the majority of these cases are caused by infection from the bowel, in many instances a fistula results, requiring subsequent treatment.

Fistula in Ano.

Fistula in ano is a sinus passing from the rectum to a cutaneous opening in the neighborhood of the anus. The older writers were accustomed to describe three forms: a blind internal, a blind external, and one open at both extremities (Fig. 281). It is obvious that only the latter form can properly be classed as a fistula. Blind internal sinuses generally result from rupture of an abscess into the rectum; blind external sinuses practically never persist unless due to a foreign body, bone disease, or to a tuberculous, syphilitic, or actinomycotic focus.

In the majority of instances a fistula is the result of an ischiorectal abscess which has been caused by a break in the mucous membrane of the rectum. After the abscess is evacuated, mucus and intestinal matter continue to leak from the bowel into the abscess cavity, which prevents healing and results in the formation of a narrow sinus lined with granulation-tissue. The sinus may be straight, easily admitting a probe; or it may be exceedingly tortuous and have several cutaneous orifices situated at a distance from each other. A small number of fistulæ are tuberculous in origin.

Fig. 281.

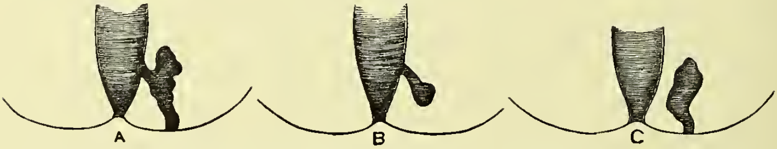


Diagram of three forms of anal fistula. (Roberts.)
A. Complete fistula. *B.* Incomplete internal fistula. *C.* Incomplete external fistula.

Diagnosis.—As a rule, the patients complain of nothing but a slight mucous or mucopurulent secretion, which constantly exudes from a minute opening, which may be situated in the scar of an incision or may be surrounded by a bluish elevated papule. In some cases the entire ischiorectal region is indurated and presents numerous fistulous openings. On rectal examination the finger may often detect an elevated papule which is the seat of the internal opening. The passage of a probe from the external to the internal opening establishes the diagnosis. This, however, is often impossible without general anæsthesia on account of the tortuous character of the sinus and the sensitiveness of the parts.

Treatment.—When multiple openings exist, these should be followed up and freely opened to the main focus; a grooved director should then be passed from the main focus to the internal opening, and all the tissues divided by passing the blade of the knife along the groove in the director. An effort should always be made to divide the sphincter muscle but once, and then transversely to the direction of its fibres. The entire sinus should be thoroughly curetted and touched with the actual cautery, or it may be completely dissected from the surrounding tissues and removed. The wound should then be tightly packed with sterile or iodoform gauze, and an external pad of gauze applied and held in place by a T-bandage. The bowels should be confined for three or four days, after which a purge and enema may be given. After each evacuation of the bowels the parts should be irrigated and the wound firmly packed to insure healing from the bottom. Suture of the wound after dissecting out the sinus with a view to obtaining primary union is successful in a certain number of instances. If this plan is followed, the bowels should be confined for from six to ten days. Considerable time may be saved by this procedure even if that portion of the wound nearest the bowel does become infected. It occasionally happens that the opening into the rectum is so high (three inches or more) that the ordinary method of treatment cannot be carried out. In these cases it is better to expose the opening into the rectum by a large incision and close it by layer sutures, or to perform an inguinal colostomy, and attempt to close the rectal wound from within through a large rectal speculum.

Stricture of the Rectum.

Stenosis of the rectum, as in other portions of the alimentary canal, may be caused by new growths, by inflammatory thickening of its walls, by a cicatricial contraction following the healing of an ulcer, or by outside pressure.

Inflammatory or *fibrous stricture*, which alone will be considered in this section, is a fairly common affection, and in the majority of instances is the sequel of simple ulcer, dysentery, gummatous ulceration, trauma, or chancroidal disease. The stricture may be situated in any part of the rectum, but is generally found within three inches of the anus. As a rule, the constricting band completely encircles the gut and is limited in extent, giving rise in some instances to a condition similar to that produced by a cord tied around the bowel.

The **symptoms** of stricture of the rectum are pain, a gradually increasing constipation with occasional attacks of diarrhœa accompanied by tenesmus and the passage of mucus and blood, indefinite digestive symptoms, and in later stages a gradual distention of the abdomen.

Defecation becomes painful and slow, great straining being required. The stools, when diarrhœa is not present, are small in size and often flattened like ribbons. When the stricture is situated low down within reach of the examining finger, the diagnosis is easy. When higher up, the proctoscope reveals the presence of a narrow opening surrounded by an indurated ring of cicatricial tissue.[1]

Treatment.—Fibrous strictures of the rectum are best treated by gradual dilatation, solid rubber or gum-elastic bougies being employed. When the stricture does not yield to this treatment linear proctotomy may be employed. This consists in dilating the sphincter, exposing the interior of the gut by a wire speculum, or retracting the walls by ordinary flat retractors, and incising the band in the median line. Following the operation the rectum should be frequently irrigated with warm salt solution, and full-sized bougies passed every second day until healing has occurred. In severe cases when extensive ulceration exists and the walls of the rectum are widely infiltrated (a condition commonly found in old syphilitics), physiologic rest of the organ by a temporary inguinal colostomy, and frequent irrigation of the sigmoid and rectum from above, are to be recommended. In more advanced cases, where these measures are ineffectual, resection of the diseased area is to be advised, as in cases of malignant disease.

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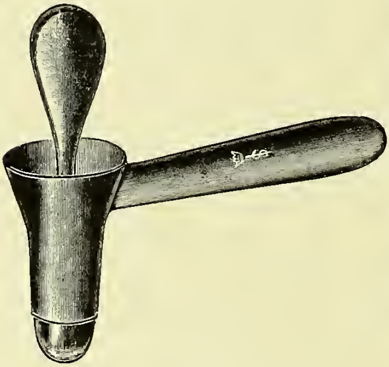
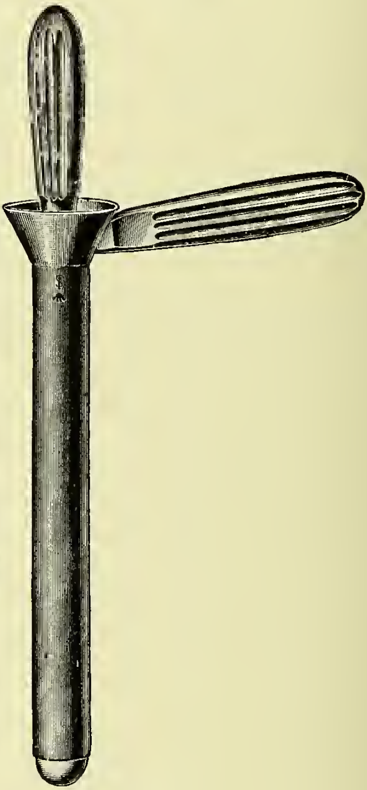
[1] Examination of the interior of the rectum should always be made in suspected disease of this portion of the alimentary canal. With the aid of the Kelly proctoscope or sigmoidoscope the bowel can be easily and thoroughly examined for a distance of twelve or fifteen inches. When the short instrument is used, the patient should be in the knee-chest position. The longer tube may also be employed while the patient is in Sims position (Figs. 282 and 283).

Fig. 282.



Kelly's proctoscope.

Fig. 283.



Sigmoidoscope.

Ulcer of the Rectum.

Ulcers of the rectum develop as a result of a number of local and constitutional conditions. Of the former may be mentioned trauma from hardened feces, fish-bones, or other foreign bodies; portal congestion, giving rise to hemorrhoidal ulcers or varicose ulcers higher up in the rectum ; dysentery, chancroidal disease, and acute proctitis. Of the constitutional causes may be mentioned tuberculosis, syphilis, actinomycosis, diabetes, chronic nephritis, and the condition known as marasmus. Carcinomatous ulcer will be considered elsewhere.

Simple or **non-specific ulceration** of the rectum is rare in childhood. It occurs most frequently in middle-aged females. It is generally associated with chronic constipation, a torpid liver, and digestive disturbances which result in a varicose condition of the veins in the lower segment of the rectum. If to this be added an abrasion of the mucous membrane, infection takes place, and an ulcer is formed with a round-cell infiltration of the submucous tissues. The process is prone to extend in the direction of the bloodvessels, and consequently tends to encircle the gut. If the ulceration is limited to the mucous membrane, recovery may occur; if, however, the deeper tissues are involved in the destructive process, healing may result in marked stenosis of the canal, a condition which has been described as fibrous stricture.

Chancroidal ulcers are exceedingly rare in this country. They occur most commonly about the anus, rarely above the sphincter muscle. In debilitated subjects they may spread rapidly and cause great destruction of tissue.

Tuberculous ulcers are almost always secondary to tuberculous disease elsewhere. They occur most frequently at or near the anal orifice, and are frequently associated with fistulæ and marginal peri-anal ulcerations. When limited to the interior of the bowel, they occur as single or multiple oval, punched-out ulcerations with overhanging edges, which may coalesce, forming large irregular-shaped losses of tissue. In the upper part of the rectum they generally surround the gut.

Syphilitic ulcers are usually tertiary, are caused by a breaking down of gummatous masses, and may give rise to great destruction of tissue. They occur low down in the rectum, and are generally followed by a contracting scar which results in obstinate stricture. Tuttle calls attention to the fact that such ulcerations are frequently associated with a peculiar dry and brittle condition of the anal mucous membrane.

Primary and secondary syphilitic lesions may also be found in the rectum, but rarely produce destructive ulcers. Mixed infection may occur in syphilitic ulcerations, and the resulting strictures may differ in no way from those resulting from simple ulcerations.

The ulcers resulting from *actinomycosis* are generally associated with extensive infiltrations of the perirectal tissues.

Symptoms.—Ulcers of the rectum from whatever cause usually give rise to certain well-marked symptoms. Pain is generally present, more particularly in ulcers situated low down within the grasp of the sphincter muscle. If high up in the rectum, the pain is often of an aching character, and may be referred to the penis, neck of the bladder, or coccyx. Tuberculous and syphilitic ulcers, as a rule, give rise to less acute pain than the other varieties. Diarrhœa, with the passage of mucus and blood, is not infrequent. The diarrhœa is most marked in the morning, and rarely disturbs the patient at night. Relaxation of the sphincter is a symptom in some cases. In all suspected cases the diagnosis should be confirmed by an ocular examination by means of the proctoscope.

Treatment.—Simple hemorrhoidal or varicose ulcers should be treated by rest in bed, frequent irrigation of the rectum with warm saline solution, and the local use of astringents by injection or suppositories. Injections of glycerite of tannin (1 part to 20 of water) or of mild solutions of silver nitrate are to be recommended; also suppositories of iodoform or tannic acid. Chancroidal ulcers should be touched with pure carbolic or nitric acid, followed by irrigation and anodyne suppositories. Tuberculous ulcerations may be curetted and dusted with iodoform, although many cases are undoubtedly made worse by local measures. Cod-liver oil, creosote, and hygienic measures should be employed. In the gummatous stage of syphilitic ulcerations the internal administration of mercury and potassium iodide will often be of marked value. As in the treatment of chronic ulcer of the leg, rest in the horizontal position will greatly facilitate the treatment of chronic rectal ulcerations.

Fissure of the Anus.

Fissure of the anus consists in a small longitudinal ulcer of the mucous membrane of the anus, usually situated on the posterior aspect of the orifice between the folds of the puckered integument. It is often concealed from view, and may only be seen by drawing the folds well apart by the fingers. It is frequently associated with hemorrhoids or pruritus ani, and is caused generally by an abrasion from the passage of hardened feces.

The **symptoms** of fissure are a severe burning pain immediately after defecation, which may persist for several hours, the presence of a slight mucous secretion, and the occasional appearance of a few drops of blood after a constipated movement.

The **treatment** should consist in absolute cleanliness, hot sitz baths, and stretching the sphincter under general anæsthesia. In obstinate cases incision along the floor of the fissure with dilatation of the sphincter will generally effect a cure.

Pruritus Ani.

Pruritus ani is an intolerable itching of the skin and mucous membrane of the anal margin without eczema or other cutaneous lesions. It occurs chiefly at night, and is frequently associated with fissure or hemorrhoids, but may be wholly of nervous origin.

The **treatment** should embrace measures to improve the general health and nervous tone of the individual, and the local use of hot water, followed by the application of a solution of carbolic acid (1 : 100) on a soft linen compress.

Benign Tumors of the Rectum.

Of the benign tumors which occur in the rectum, **adenomata** are the most frequent. They may occur as single pedunculated growths or as multiple tumors involving a large extent of mucous membrane. The tumors are, as a rule, soft, freely movable, and if situated low down in the bowel may protrude through the anus. **Papillomata,** or villous tumors, **angiomata, fibromata, myxomata,** and **lipomata,** are rare. The term rectal *polyp* is used clinically to describe any soft pedunculated benign tumor growing from the mucous membrane of the rectum. In the majority of instances rectal polyps are found to be adenomata.

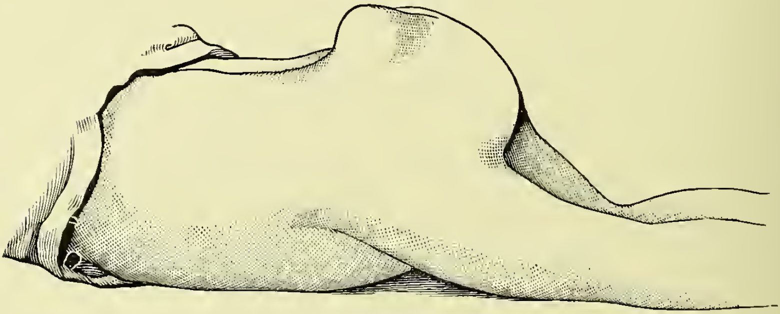
The **symptoms** of benign growths are chiefly those of a foreign body in the bowel. If the growth is situated low enough to engage in or protrude through the sphincter, pain and tenesmus may be present. If ulceration of the mucous membrane occurs, there may be hemorrhage. Stenosis of the gut is rare, and never gives rise to complete obstruction. In the majority of instances benign tumors situated well above the sphincter muscles produce no symptoms, and are discovered only as a result of systematic rectal examination by the finger or speculum.

The **treatment** of polyps and other small growths should be complete removal, which is easily accomplished with scissors, cutting forceps, or the wire snare, if the growth is accessible. In tumors involving a large area of the bowel the growth may be attacked from behind by the Kraske procedure, or a resection may be necessary.

Dermoids of the Rectum.

Dermoids of the rectum are rare. When they do occur, they generally involve the posterior wall of the gut, and present, as a rule, long locks of hair which project into the lumen of the bowel and may protrude through the anal orifice. Dermoids occurring between the rectum and sacrum and coccyx (*post-rectal dermoids*) are more common and attain a larger size. They may develop below or above the levator ani muscle. Those which develop below the muscle arise, as a rule, from the anococcygeal body, the remnant of the neurenteric canal. They are often spoken of as *thyrodermoids* on account of their resemblance in structure to thyroid tissue (Fig. 284). Those which develop above the muscle often reach an enormous size. As a rule, they contain pultaceous material, hair, and teeth.

Fig. 284.



Anococcygeal dermoid.

The **treatment** of dermoids not involving the rectal wall is by enucleation after exposure of the cyst-wall. In those involving the wall of the gut partial excision will be necessary. The best exposure in these cases is to be obtained by the sacral operation described under the treatment of malignant neoplasms of the rectum.

Malignant Tumors of the Rectum.

Carcinoma of the rectum is a fairly common disease. Tuttle states that nearly 5 per cent. of all cancerous growths occur in the sigmoid, rectum, and anal region. The disease presents several distinct varieties. Thus *epithelioma* occurs at the junction of the skin and mucous membrane at the anus, and differs in no respect from superficial epithelioma elsewhere. *Adenocarcinoma* is the commonest variety found within the bowel. Next in frequency comes *scirrhus*, the hard fibrous constricting growth ; and lastly, the *medullary* or the very cellular variety. Cancer of the rectum is a disease of late middle life, occurring most frequently in individuals between forty and sixty years of age. It is slightly more common in men than in women. In the majority of instances it is located in the upper part of the rectum. Tuttle's tables show that 56 per cent. of the cases occur in the supraperitoneal portion, 18 per cent. in the infraperitoneal portion, 15 per cent. in the sigmoid, and 9 per cent. at the anus.

Metastasis takes place through the lymphatics, at an early period in the more cellular growths, later in the fibrous and adenomatous varieties. The iliac and lumbar nodes are chiefly enlarged; the inguinal also if the disease involves the anus.

The **symptoms** of cancer of the rectum resemble at first those of hemorrhoids or ulcer, if the disease is situated in the lower segment of the tube. Thus there is more or less constipation, deep-seated pain, hemorrhage, and tenesmus. If the growth is located higher up, the first symptoms are often those of stricture. The patient experiences more and more difficulty in obtaining a satisfactory movement of the bowels, with or without occasional pain and discomfort. Later, attacks of incomplete obstruction occur, with pain and general abdominal distention, which are usually relieved by cathartics and enemata. The stools become progressively smaller in size and amount, and the mass of retained fecal matter above the constriction may occasion irritation resulting in recurrent attacks of enteritis, during which diarrhœa may be present, with the passage of mucus and blood. Thin, ribbon-shaped stools are occasionally observed if the growth is near the anus.

The **diagnosis** can generally be made by digital examination if the growth is accessible, by the proctoscope if beyond the reach of the finger. To the examining finger the growth generally gives the impression of a dense nodular mass involving all the coats of the rectum. In many cases the growth completely surrounds the bowel, constricting the lumen to a small size. The edges of the constriction are frequently ulcerated and bleed easily when touched.

Progressive anæmia, loss of weight, and cachexia occur in this as in other cancerous affections, and metastases appear in the liver and other organs.

Sarcoma of the rectum is a rare disease. It attacks by preference the lower segment of the organ, and arises in the submucous cellular coat. As in other situations, it presents varying degrees of malignancy according to the rapidity of its growth and its histologic characteristics. The growth of a spindle-cell sarcoma may be comparatively slow, and recovery may follow its complete removal. Lymphosarcoma, on the other hand, is generally fatal in a few months after the diagnosis is made, in spite of any and all treatment.

The **diagnosis** can usually be made by observing the rapidity of the growth, its situation in the lower segment of the gut, the fact that the mucous membrane is at first freely movable over the tumor mass, and by the absence of stenosis. In ulcerating soft sarcomata hemorrhage may be profuse.

Treatment of Malignant Tumors of the Rectum.—Epithelioma of the anus, when limited in extent, should be thoroughly excised and the mucous membrane of the bowel drawn downward and stitched to the cutaneous margins; if more extensive, the disease should be attacked from behind by the Kraske method, soon to be described, and the lower portion of the bowel, the sphincter muscle, and a large area of surrounding skin removed. The healthy intestine should then be brought downward and a new anus formed either at the site of the old one or at a higher point through the sacral opening. In women a fair exposure of the lower segment of the rectum can often be made by a longitudinal division of the posterior vaginal wall.

In the presence of malignant disease in the upper rectum or sigmoid three methods may be employed:

First.—Extirpation of the rectum by the sacral route (Kraske). This consists in removal of the coccyx and a part (Hochenegg), or the whole (Bardenhauer), of the lower one or two segments of the sacrum, separating the rectum from the surrounding tissues, removing the diseased area, and uniting the proximal and distal portions with two or more rows of sutures; or removal of the entire lower segment of the organ and creating a sacral anus. In this operation the upper portion of the rectum and a part of the sigmoid often can be brought down into the wound by opening the peritoneal cavity and severing all of the peritoneal attachments except the mesentery.

When it seems desirable completely to remove the lower portion of the rectum and create a sacral anus, the upper segment of the bowel should be drawn outward at the upper angle of the incision, rotated on its longitudinal axis for about 180 degrees, and stitched to the cutaneous wound. After recovery from the operation this orifice can be guarded by a specially constructed truss with a pneumatic rubber ring.

Second.—The abdominal or combined operation. The patient should be placed in the Trendelenburg posture and the abdominal cavity opened by a median incision extending from the umbilicus to the symphysis. The intestines are drawn upward and retained by large gauze pads, leaving the pelvic cavity well exposed. The area of the disease is next appreciated and the presence or absence of enlarged lymph-nodes noted. An incision is then made along the left border of the mesentery, dividing the peritoneum only. This should extend upward to the region of the inferior mesenteric artery and all enlarged lymph-nodes and surrounding areolar tissue removed. This is easily accomplished by gently stripping the subperitoneal tissues from the muscles by a gauze sponge as the bowel is being drawn over toward the median line, care being taken to avoid the ureter and superior hemorrhoidal vessels. The bowel is then clamped and divided well above and below the diseased area and the proximal and distal extremities inverted and closed by purse-string sutures. The diseased portion is next removed with the lymph-nodes and areolar tissue, the two closed segments of the bowel approximated and a lateral anastomosis performed. When, on account of the low situation of the growth, this anastomosis is impossible, an effort should be made to draw the upper segment of the gut downward sufficiently to reach the anal orifice. If this is difficult or impossible the descending colon can be still further freed by ligature and division of the superior hemorrhoidal artery near its origin, or even of the inferior mesenteric trunk, as recently suggested by Moynihan, the circulation in the lower portion of the sigmoid being carried on by a long arterial loop which runs parallel with the intestine and joins a similar loop from the colica media. When the upper loop is sufficiently mobilized, the peritoneum passing from the floor of the pelvis to the rectum is divided and the bowel separated from the levator muscle well down into the ischiorectal fossa. The patient is next placed in the lithotomy position, and an incision made to the left of the anus sufficiently long to enable an assistant to still further separate and draw downward the rectal stump, which is finally inverted through the anus and cut off, care being taken to leave the sphincter muscle intact. A long-bladed forceps is next passed upward through the now denuded sphincter and the upper loop of sigmoid drawn downward and stitched to the cutaneous margin of the anus. The last step in the operation is to unite the peritoneum about the transplanted sigmoid, close the abdominal cavity, and insert a large mass of gauze for drainage in the perineal wound.

Third.—Complete removal of the lower segment of the bowel and the formation of an inguinal anus. Perform a laparotomy as in the preceding operation, expose the disease, follow up and remove the lymphatics to the junction of the inferior mesenteric artery and aorta. Next divide the sigmoid well above the growth, close both ends with purse-string sutures, and draw the upper loop outward through an intermuscular opening near the anterior superior spine, where it is fixed by two or three cutaneous sutures. The entire lower segment of the bowel is then freed from its attachments and removed with its mesentery and all infected lymph-nodes and areolar tissue in the manner just described, after which the peritoneum of the floor of the pelvis is united and the abdominal wound closed. The protruding end of the bowel should not be opened until the following day, after adhesions have formed, which completely shut off the peritoneal cavity.

While rectal cancer has, in the past, been justly regarded by surgeons as an almost hopeless condition, the report of a recent series of 100 cases by Tuttle, with an operative mortality of 13 per cent. and 26 per cent. of cures three years after operation, gives much encouragement, and shows the effect of the modern more radical methods of operation. In a certain percentage of cases, however, the surgeon is not consulted until the disease is so far advanced as to be inoperable. A large measure of comfort can be given to these unfortunate individuals by colostomy, which diverts the intestinal current, lessens the pain, and removes the distressing tenesmus.

Hemorrhoids.

Hemorrhoids, or piles, is a varicose dilatation of one or more of the veins in the lower portion of the rectal mucous membrane. The hemorrhoidal plexus is formed by a large number of veins which originate in small dilated *pools* or spaces located in the submucous tissue just above the anorectal junction. Each of these in health is about the size of a grain of wheat, and gives origin to a vein which passes upward, freely anastomosing with its numerous fellows, and eventually piercing the muscular coat of the bowel about three inches above the anus, to enter the radicals of the portal system. From the lower extremity of these small pools minute anastomosing branches emerge which empty into the external hemorrhoidal veins located immediately under the integument at the anal orifice (Tuttle).

Under conditions of portal congestion from chronic constipation, congested liver, cirrhosis, valvular disease of the heart, etc., these small veins become engorged, and permanent dilatation results. If the dilatation is limited to the external hemorrhoidal veins, the condition is described as one of *external piles;* if limited to the small venous pools within the rectum, it is spoken of as *internal piles;* if both are involved in the process, the term *mixed piles* is employed. In any of these situations thrombosis may occur, giving rise to bluish oval indurated masses, *thrombotic piles*, or infection may be added, giving rise to a condition of localized phlebitis, or *inflamed piles*. Occasionally a cluster of *internal piles* will be forced outward through the sphincter muscle, and by its contraction the mass becomes strangulated. Such masses often resemble a miniature bunch of grapes, and if not quickly reduced ulceration or sloughing may result.

Symptoms.—Chronic dilatation of the hemorrhoidal veins is undoubtedly present in many individuals without causing symptoms. In certain cases, however, there is a sense of weight and pain in the rectum, accentuated by defecation. This may persist for one or more hours and prevent sleep. If the cluster of internal hemorrhoids is large, the patient may experience a feeling of a foreign body in the rectum, which is not relieved by defecation. Hemorrhage due to superficial ulceration is a fairly constant symptom in internal piles, and in many cases it is profuse.

If a mass of internal piles becomes strangulated, or if thrombosis and infection occur, the pain is greatly increased in severity, and is accompanied by local tenderness and fever. All of these symptoms are aggravated by defecation, walking, or sitting. The patient is confined to his bed, and often experiences great suffering for several days. An individual in this condition is generally spoken of as "having an attack of piles." As a rule, the symptoms subside after a few days under appropriate treatment. In exceptional cases general infection may occur from disintegration of the septic thrombus and dissemination by the circulation. There is a popular impression that itching is a symptom of piles. While this symptom is frequently associated with piles, it is rarely due to the venous dilatation, but rather to an associated fissure, eczema, or pruritus. Intense itching is said to be occasionally caused by the small thick skin-tabs so frequently seen about the anus in individuals whose external piles have been spontaneously cured by thrombosis and obliteration of the vessels.

The **diagnosis** is easily made by inspection of the parts, drawing aside the folds of the anus, and instructing the patient to bear down. By this method not only the external piles are made prominent and filled with blood, but also the lower portions of the internal hemorrhoids are brought into view. Unless the veins are inflamed, greatly thickened, or contain thrombi, they cannot be appreciated by digital examination. Examination by the short proctoscope in the knee-chest position is often negative, for the reason that in this position the veins are emptied and collapsed.

Treatment.—The tendency to hemorrhoids should be combated by exercise, restricted diet, and measures to avoid constipation and portal congestion.

Strangulated or inflamed piles should be treated by hot sitz baths, rectal irrigations when they are possible, moderate catharsis, and the local application of soothing ointments or poultices. If the condition is not such as to confine the patient to the bed, the following prescription will be found serviceable :

℞ Ung. gallæ,
Ung. stramonii, āā ℥j.
Sig.—Apply morning and night.

Thrombosed and infected external piles are often promptly cured by incision, turning out the clot, and packing the wound with sterile gauze.

The *radical treatment* of hemorrhoids consists in three procedures: obliteration of the lumen of the vein by the injection of carbolic acid; removal of the individual tumors; or removal of the pile-bearing area of the rectal mucous membrane.

The injection method is largely employed by irregular practitioners, often with excellent results. It has the advantage that it allows the patient to be up and about during treatment. It consists in the injection of from 3 to 10 drops of a 20 per cent. solution of carbolic acid into the centre of the pile. The parts should be thoroughly disinfected and the needle introduced from below at a point where the hemorrhoid joins the healthy mucous membrane.

Tuttle recommends the following formula:

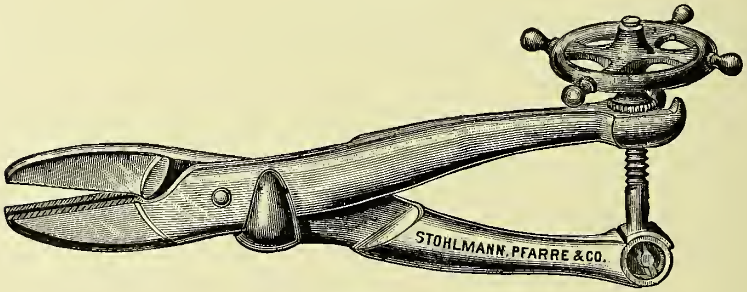
℞	Acid. carbolici (Calvert's),	ʒij;
	Acid. salicylici,	ʒss;
	Sodii boratis,	ʒj;
	Glycerinæ (sterile),	℥j. M.

The immediate result of the injection is to cause a painful swelling of the pile, which subsides in two or three days, leaving only a thickened area of mucous membrane.

Removal of the individual tumors is accomplished by several methods. In all, the patient should be anæsthetized and placed in the lithotomy position. The sphincter should then be thoroughly stretched, temporarily paralyzing its fibres.

The simplest method of removal is by *crushing* the pile with the angiotribe (Fig. 285). The method by *ligation and excision* is the one most generally employed in this country. The pile is grasped by a pair of forceps and drawn downward. Its base is next encircled by a cut which divides only the mucous membrane. A straight needle threaded with heavy silk is then passed through the base of the tumor and securely tied above and below, care

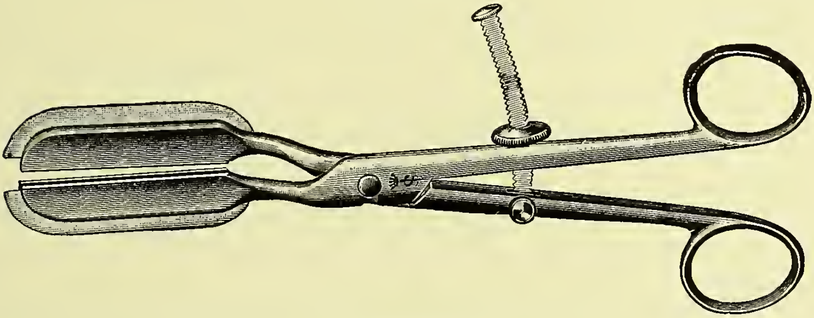
FIG. 285.



Angiotribe.

being taken to avoid including in the knot any of the rectal mucous membrane. The summit of the pile is then removed with scissors. The method by the *clamp and cautery* consists in grasping the summit of the pile by a pair of toothed forceps, drawing it well downward and applying a Smith clamp (Fig. 286) at the base. The summit of the tumor is then removed with scissors and the stump slowly cauterized with a cherry-red Paquelin point.

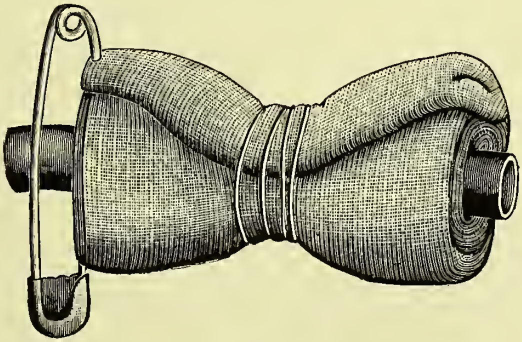
Fig. 286.



Smith clamp.

After any of these methods a gauze-covered spool-shaped rectal tube should be introduced and held in position by four tape-bands (Fig. 287). This prevents hemorrhage and allows the escape of flatus. It should be removed on the fourth day and the bowel injected daily for one week with a solution of glycerite of tannin (1 : 16).

Fig. 287.



Rectal tube.

Removal of the entire pile-bearing area of the rectal mucous membrane (*Whitehead's operation*) consists in making a circular incision at the margin of the mucous membrane and skin of the anus, separating the mucous membrane from the muscular coat for a distance of from two to three inches, then cutting off the pile-bearing membrane, and suturing the healthy mucosa to the skin. This operation may be relied upon to cure the piles, but it has the disadvantage that it removes that portion of the mucous membrane which contains the sensory nerves entering into what may be called the anal reflex, or the involuntary tightening of the anal orifice when the sensation of solid matter, fluid, or gas is felt in the lower rectum. The writer has seen several patients in whom rectal incontinence was present, yet who seemed to possess the ability voluntarily to contract the sphincter as well as before operation. Another objection to the operation is the possibility of infection, sloughing, and retraction of the mucous membrane, leaving a large circular granulating area which heals slowly and is invariably followed by a dense stricture.

Prolapse of the Rectum.

Prolapse of the rectum is a projection downward of the mucous membrane of the bowel through the anal orifice. This occurs to a slight extent in healthy individuals during a constipated movement. The membrane, however, is quickly drawn upward by contraction of the sphincter, and no untoward symptoms are produced.

If more of the mucous membrane is prolapsed, and it is not immediately replaced by contraction of the sphincter, the condition is called *prolapsus ani*. If the disease progresses and the entire wall of the gut is protruded, the condition is spoken of as *prolapsus recti*.

The disease is more common in children than in adults, and is caused by constipation, severe rectal or bladder tenesmus from any cause, the presence of hemorrhoids or other rectal tumors, and from general weakness and muscular relaxation. In the early stages reduction is readily effected by gentle pressure with the fingers. In the later stages the prolapsed bowel becomes much thickened, and when reduced shows a strong tendency to reappear.

The **diagnosis** is easily made by observing the presence of an oblong, sausage-shaped, pink or bluish mass protruding from the anus.

The **treatment** should consist in removal of the cause when this is possible, the use of astringent injections, and the habitual employment of a commode so constructed that the seat is made to slant from behind forward at an angle of thirty or forty degrees from the horizontal. This prevents the patient assuming a position in which excessive straining is possible.

If these measures fail, linear cauterization of the rectal mucous membrane for a distance of two or three inches above the sphincter is to be advised. This should be done under general anæsthesia, the Paquelin cautery being employed, and three or four deep eschars made equidistant from each other. In children the cauterization may be accomplished by the application of pure carbolic acid to the prolapsed bowel by means of a glass rod or pointed stick. When the acid has produced its effect, it should be washed off with alcohol and salt solution, after which the prolapse should be replaced and the bowels confined for two or three days. Recurrence should be prevented by the use of laxatives, enemata, and the slanting-seat commode. In obstinate cases of prolapse of the mucous membrane the Whitehead operation described on page 648 has been recommended; also excision of a portion of the rectum. These methods, however, are inferior to *sigmoidopexy*, which is the operation of choice in obstinate cases. This consists in opening the abdomen by means of the intermuscular method, in the left inguinal region, drawing the sigmoid well upward and attaching its mesentery to the peritoneum and iliac fascia by means of two or three chromicized catgut sutures.

CHAPTER XXV.

DISEASES OF BONE.

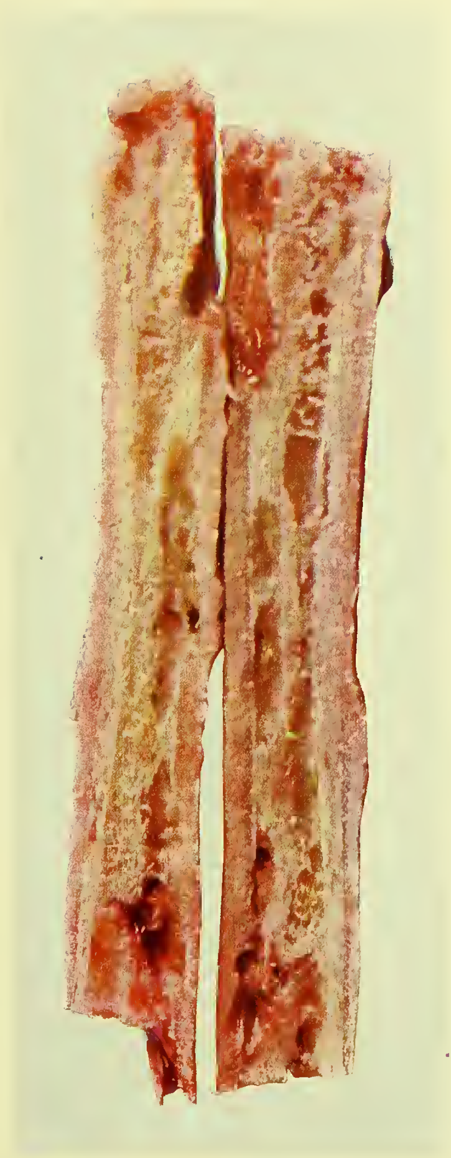
INFLAMMATION OF BONE.

Acute Osteomyelitis.

Acute osteomyelitis is an infectious inflammation of bone. The older surgeons were accustomed to describe three varieties of the disease: *periostitis*, or inflammation of the periosteum; *osteitis*, or inflammation of the denser portion of the bone; and *osteomyelitis*, or inflammation of the bone-marrow and cancellous tissue. A better understanding of the pathology of the affection, however, has demonstrated that these are simply different stages of the same pathologic process, which at one time or another generally involves all of the structures of bone. Septic processes in bone differ in no respect from similar processes in the soft parts, except in so far as their symptoms and results may be modified by the unyielding nature of the tissue.

Two forms of the disease are described, the **traumatic** and the **non-traumatic** or **idiopathic**. The former variety occurs obviously at any age; the latter is commonest in children and young adults. The cause of acute osteomyelitis is invariably the invasion of the tissues by pathogenic micro-organisms, either through a wound exposing and injuring the bone, through the blood-current, or through the lymphatics. Of the various micro-organisms which may give rise to osteomyelitis, *Staphylococcus pyogenes aureus* is the one most frequently found; the others in the order of their frequency being the *streptococcus*, the *pneumonococcus*, the *typhoid* or *colon bacillus*. The process may begin in any part of the bone; but in the non-traumatic or so-called idiopathic cases the infection usually first occurs in the interior, and in the majority of instances near an epiphysis. The first result of the microbic invasion is a reactionary hyperæmia and the occurrence of an inflammatory exudate. Owing to the unyielding nature of the tissues this at once produces sufficient pressure greatly to impede or totally arrest the circulation, and a more or less extensive necrosis of the ischæmic tissue takes place. If the area of necrosis is small and limited to the thin cancellous structure and

PLATE XIII



Acute Osteomyelitis of Tibia.

Colored photograph of a fresh specimen removed from a child six years of age (Lumiere process.)

bone-marrow, a circumscribed focus of suppuration results (*bone-abscess*). At a later period this abscess, unless relieved, becomes surrounded by a layer of dense bony tissue, forming a protecting capsule. In rare instances this sclerosis may extend and involve a large part of the shaft of the bone. When the disease involves a large area, as the diaphysis of a long bone, the pus rapidly extends in the direction of least resistance, which is along the medullary canal (Plate XIII). A barrier is reached at the epiphysis, as septic inflammations rarely pass this point. The infection, as a rule, burrows outward through the cortex, and often just beneath the epiphyseal cartilage until the external surface of the bone is reached. Here it may give rise to suppuration, which spreads rapidly beneath the periosteum, separating it from the bone (*subperiosteal abscess*), and when the tension causes a rupture of the membrane it spreads between the muscular and fascial planes, and may eventually discharge on the surface of the limb. Septic involvement of a neighboring joint may rarely occur, giving rise to pyarthrosis, which is not infrequently overlooked. This occurs more often in adults and when the offending organisms belong to the steptococcus group. In severer cases, unless relieved by prompt surgical intervention, the area of necrosis extends rapidly, and may involve a large portion or even the entire diaphysis of the bone.

In these cases an acute hyperæmia occurs above and below the necrosed area, which eventually results in a softening and liquefaction of the tissues at the junction of the dead and living bone. The periosteum becomes congested and produces an abundant exudate, which, later, becomes calcified and forms a cylindric bridge between the proximal and distal healthy portions of the bone. This bony case or *involucrum* encloses the necrosed portion of the shaft, or *sequestrum*, which sooner or later becomes loosened and lies free within its bony envelope. The involucrum is perforated at one or more points, allowing the escape of the pus which is always present within its cavity.

In the very acute cases septic thrombi form in the veins situated within the bone and in the surrounding soft tissues. These may soften, and small portions may be carried by the general circulation to distant parts of the body, giving rise to metastatic accidents.

In extensive osteomyelitis of the larger bones the resulting toxæmia may be so great as to cause death in two or three days.

Symptoms.—In the so-called idiopathic cases the symptoms at first are simply those of a severe infectious disease; chills, fever, and prostration may occur without local pain or other evidence pointing to the seat of the lesion. In the most virulent cases the temperature may rise to 105° or 106° F., and the toxæmia may be so rapid and profound as to cause delirium and stupor before the patient experiences pain or is able to indicate its location. In these cases ulcerative endocarditis and a general petechial eruption are frequently found at an early period, and point to a rapidly fatal termination. In the less virulent cases pain is an early symptom, and varies in severity from a dull aching sensation to the most acute suffering. With the pain there is more or less tenderness of the affected limb, easily appreciated by pressure over the bone, or by forcibly striking the sole or palm of the extremity in an extended position. Œdema and a slight lividity of the skin are noticeable in some cases. Œdema of the periosteum, seen on exploratory incision, is one of the most reliable signs of bone infection. In the later stages deep-seated or superficial fluctuation may be made out, and a palpable thickening of the shaft of the bone is present. In all acute cases, except the extremely virulent, a marked leucocytosis is present. In the severest intoxications, however, occurring in individuals with greatly diminished vital resistance, leucocytosis may be absent. When the disease follows a compound fracture, amputation, or other bone lesion, the local symptoms are generally the first to excite the suspicion of the surgeon. In these cases there are evidence of wound-infection, deep-seated pain over the affected bone, and general toxæmia. The degree of the latter is rarely as severe as in the non-traumatic cases for the reason that the products of inflammation find an exit, though often an imperfect one, through the open extremity of the medullary canal.

Treatment.—In the acute fulminating cases accompanied by the rapid development of grave sepsis, the treatment, to be successful, should be inaugurated at an early period. The bone should be exposed by a generous incision, the periosteum divided and stripped from its surface, and the medullary canal freely opened by the chisel and mallet. The infected marrow and cancellous tissue should be thoroughly scraped away, the cavity disinfected with pure carbolic acid or formalin (1 : 50), and packed with gauze. If abscesses are found beneath the periosteum or in the soft tissues, they should be evacuated and drained with rubber tubes. The subsequent treatment should consist in antiseptic dressings until the extent of the necrosis is evident. If the shaft of the bone retains its vitality, the cavity will slowly fill with granulations, and recovery may occur without further surgical intervention. This method is the most radical, and is indicated in the severest type of the disease to quickly overcome the threatening toxæmia. It has the disadvantage, however, of removing the endosteum, which results in slow repair, and many of the cases never heal without secondary operations. Simple removal of a strip of the cortex without disturbing the cancellous structure, as recently advocated by Nichols, is the operation of choice in the majority of cases. This provides adequate drainage, insures more rapid repair, and is associated with far less destruction of tissue.

Early treatment by these methods will prevent necrosis in the great majority of cases. It frequently happens, however, that the case is neglected and is first seen by the surgeon after a more or less extensive necrosis of the shaft has taken place. The primary treatment of these cases should be the opening and draining of all collections of pus, whether in the bone, beneath the periosteum, or in the soft parts. At a later period, as soon as the thickened periosteum begins to calcify, and before the necrosed area has separated, Nichols advises stripping the periosteum from the necrotic shaft, removal of the sequestrum, and obliteration of the cavity by pressing the walls of the involucrum together. This, he claims, greatly shortens the duration of the after-treatment, and results in a new, solid, and a comparatively small-sized shaft. This method is applicable obviously only in certain situations, as in the lower leg and forearm, where the presence of a healthy parallel bone serves to prevent shortening and deformity. In other locations it is wiser to allow the sequestrum to remain until a firm unyielding involucrum is formed, a period often of several months, and then to make an opening into its cavity for the removal of the necrosed fragments. When this is impracticable, the use of a sterile metal or ivory rod between the upper and lower healthy fragment of bone may be temporarily employed until the involucrum becomes firm. When a large bone cavity remains after the thorough removal of the cancellous tissue, or of a sequestrum, the process of repair sometimes can be hastened by the aseptic blood-clot method. This consists in sterilization of the cavity, then allowing it to fill with blood, and after its coagulation to draw the skin over it and close the wound. This succeeds in a small percentage of the cases. Another method is to remove the bony lateral walls of the cavity, to draw the soft parts over the remaining exposed bone, and to anchor them in contact with the bone by tacks or sutures (Neuber). Still another method is to fill the sterilized bone cavity with melted paraffine or Von Mosetig's iodoform bone-plug, which consists of iodoform 60 parts, spermaceti 40 parts, and oil of sesame 40 parts. These are thoroughly mixed and melted. The mass solidifies at the temperature of the body. The last method is not applicable to acute cases.

If early opening of the medullary cavity and thorough drainage fail to arrest the sepsis, prompt amputation, insuring complete removal of the diseased bone, is indicated.

Acute Epiphysitis.

It frequently happens in infants that an acute septic osteomyelotis is limited to the epiphysis of a bone. As the result is almost invariably a suppurative arthritis, the disease will be considered more fully in Chapter XXVI.

Subacute and Chronic Osteomyelitis.

Under this heading are included a number of affections possessing many features in common, but differing widely in their etiology. They are all of infectious origin, but the infecting agent is not capable of causing either rapid destruction of tissue or severe systemic reaction. In many of them the chief clinical feature of the disease is sclerosis, which is due to an excessive reparative effort. As these affections differ considerably in their general behavior, clinical history, and treatment, each will be considered separately.

Subacute cortical osteomyelitis of septic origin, also spoken of as *suppurative periostitis.* This is an inflammatory process limited to the periosteum and cortical layer of the bone, resulting in suppuration and necrosis, the latter being limited to a thin superficial plate of compact tissue which separates slowly by the processes already described.

The **symptoms** are localized pain and tenderness, the occurrence of an oval fluctuating swelling, with œdema and redness of the skin, if the disease is located in a superficial portion of the bone.

The **treatment** is by free incision, evacuation of the pus, and removal of the necrosed area.

Osteomyelitis Albuminosa.—A non-suppurating infection of bone, characterized by great thickening of the periosteum, which when incised is found to be due to the presence of a thick, gelatinous material. Dor claims to have isolated a micro-organism, with which he reproduced the symptoms in animals. The disease is rare.

The **treatment** consists in incision of the periosteum and removal of the gelatinous mass.

Typhoid osteomyelitis is a fairly frequent sequel of typhoid fever. It occurs as a small circumscribed bone infection which slowly causes necrosis of the cortex with discharge of infected material beneath the periosteum. This eventually gives rise to an abundant formation of granulation-tissue between the bone and periosteum, and occasionally rupture of that membrane and infiltration of the soft parts. In mixed infections suppuration may be present.

The **symptoms** of the disease are localized pain, often of a severe type, over a small area of bone. This continues, and is accompanied by tenderness and thickening of the periosteum, but with little or no fever. When the bone focus ruptures, the pain is relieved, and a soft subperiosteal swelling occurs, which is elastic and often gives the sensation of fluctuation. The tibia, ribs, ulna, and small bones of the hands and feet are the ones most frequently affected.

The **treatment** should be incision and drainage, with curettage and packing of the bony cavity. In the early painful stage the bone cavity should be opened, if it can be accurately located.

Syphilis of Bone.—The syphilitic lesions of bone occur both in the early and late stages of the disease. In the early stage they are, as a rule, painful but not destructive; in the late stage they are more destructive, but not, as a rule, as painful as the septic bone diseases. In the early period the disease is frequently limited to the periosteum, and consists in hyperæmia and a moderate exudate, both of which disappear under mercurial treatment; in the later period the lesions are gummatous in character, and are followed by necrosis and its sequelæ, by sclerosis of the bone, and by thickening of the periosteum. When the gummatous process occurs in the shaft of a long bone, the focus is not, as a rule, surrounded by a dense layer of compact bone, as in septic osteomyelitis, and for this reason it often is difficult accurately to determine the limits of the disease.

When the process occurs in an epiphysis it frequently perforates the articular cartilage and gives rise to a chronic arthritis, which closely resembles the tuberculous variety.

In rare instances syphilis seems to occasion only hyperplasia without previous gummatous formation. In these cases the bone is apparently greatly thickened, either from new-formed, hard osseous tissues, or from a dense fibrous thickening of the periosteum.

It will thus be seen that the tertiary lesions of syphilis in the bones consist in irregular areas of gummatous softening, irregular areas of sclerosis, and thickening of the periosteum. Martin Ware has recently called attention to these characteristic features as revealed by radiograms of the long bones, and states that the diagnosis often can be established by radiography without additional data.

The **symptoms** of the early bone lesions of syphilis are pain occurring at night in one or more bones, tenderness, and occasionally periosteal thickening. The symptoms of the later manifestations are either those of localized periosteal gummata, which may break down and cause caries or necrosis of the underlying bone, those of the subacute cortical variety of osteomyelitis, or those of a localized or diffuse osteomyelitis beginning in the interior of the bone. The syphilitic forms of osteomyelitis are to be distinguished from those due to septic infection by the absence of fever, by the absence of marked pain, and the presence of sclerosis. Gummata occurring in the interior of a long bone may rarely give rise to the same expansion of the cortex as is seen in central sarcoma.

In addition to the conditions just described, **syphilitic osteochondritis** is frequently seen in the hereditary form of the disease. This condition is characterized by an overgrowth of the epiphyseal cartilage and adjacent portions of the shaft of the long bones. When the disease occurs in the metacarpal bones or phalanges the condition is spoken of as a *dactylitis syphilitica*, which closely resembles the tuberculous variety. The disease may remain stationary, or break down and give rise to necrosis, separation of the epiphysis, or destruction of the joint.

Treatment.—In all syphilitic bone-lesions, internal treatment should be administered until the physiologic effect is apparent: mercury in the secondary stage; mercury and potassium iodide for the late lesions. If a periosteal gummatous abscess results, it should be freely opened and any cortical necrosis removed by the chisel and mallet. In central syphilitic osteomyelitis with necrosis the treatment should be the same as in the septic form described on page 652.

Tuberculosis of Bone.—Tuberculosis affects by preference the epiphyses of the long bones; it occurs also in the shafts of the metacarpals, metatarsals, and phalanges (*spina ventosa*); and in the short and flat bones. It rarely occurs in the diaphyses of the long bones, although Vignard and Mouriquand have recently reported its occurrence in the humerus, radius, clavicle, and fibula.

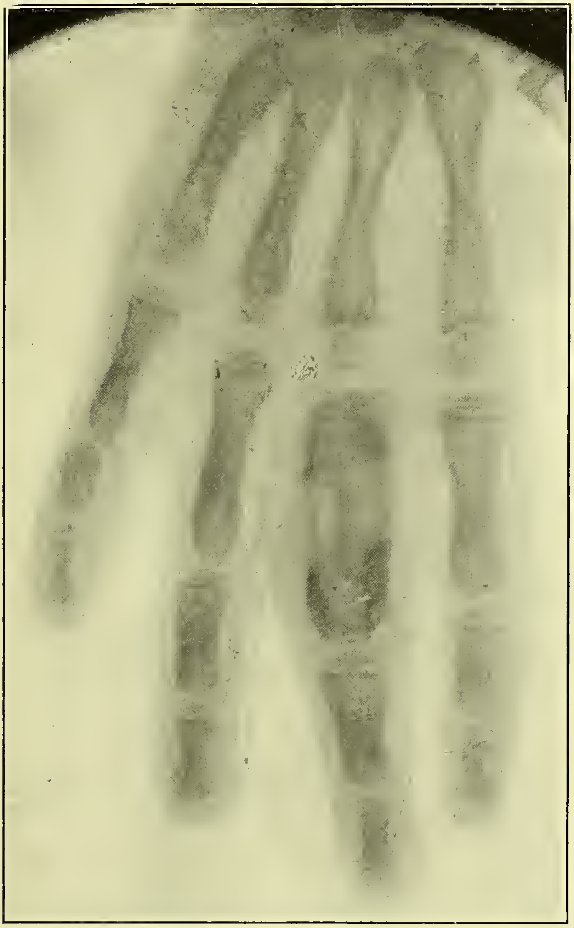
Miliary tubercles form first in the marrow, and by their coalescence a more or less extensive destruction of tissue occurs, resulting in a circumscribed *tuberculous bone abscess* or the formation of a *tuberculous sequestrum.*

In tuberculous osteomyelitis of the articular extremity of a long bone the process may begin just beneath the cartilage or on the shaft side of the epiphysis.

In either event the disease may spread and involve the joint, or may remain limited to the extremity of the bone. In the latter event a localized tuberculous bone abscess may result, surrounded by an area of sclerosis. The joint-sequelæ of tuberculous epiphysitis will be considered in Chapter XXVII.

The **symptoms** of tuberculous osteomyelitis are moderate deep-seated pain in the limb, tenderness, and a thickening of the bone. If the disease invades the soft parts, abscesses may form, which rupture on the skin and give rise to characteristic tuberculous fistulæ, described on page 187. In many cases the focus of infection is small, but the resulting sclerosis of bone is marked. The disease is prone to affect the vertebræ and the small bones of the hand and foot. *Tuberculous dactylitis* is a name given to a tuberculous osteomyelitis of the shaft of one of the phalanges. The chief characteristics of tuberculous osteomyelitis are the chronicity of the process, the absence of severe pain, leucocytosis, and evidences of general sepsis. In many cases the pain and tenderness are not sufficiently circumscribed accurately to locate the lesion. In these instances an x-ray examination will be found of great advantage (Fig. 288).

Fig. 288.



Tuberculous dactylitis (x-ray).

In the early stages the **treatment** of tuberculous bone disease should be conservative, and consists in rest, counterirritation, tonics, and hygienic measures. Elastic constriction of the limb above the seat of disease by means of a rubber band, as recommended by Bier, seems to exert a favorable influence. If, however, the disease is progressive in spite of these measures, it should be attacked surgically.

The treatment of the cortical form of tuberculous osteomyelitis, which occurs chiefly in the flat bones, is by incision and scraping away the carious bone, followed by the application of pure carbolic acid and packing with iodoform gauze. In the central variety the bone should be freely opened and the cheesy focus found and curetted. If a sequestrum is present, it should be removed and the cavity disinfected and packed. In the acute diffuse form of the disease amputation may be necessary.

Actinomycosis of Bone.—Infection of bone by the ray fungus occasionally occurs. The lower jaw is the bone usually affected, and the infection is generally supposed to take place through a carious tooth. The result is the slow development of an osteomyelitis with secondary granulomatous deposits beneath the periosteum and in the soft tissues. These latter break down and give rise to indolent fungating ulcers and sinuses which discharge a watery pus containing numerous granules of a lemon-yellow color.

The **treatment** should, if possible, consist in removal of the diseased area and the internal exhibition of potassium iodide or the salts of copper.

Sequelæ of Bone Inflammation.—These are necrosis, caries, and hyperplasia of the bone or periosteum.

Necrosis has been described as gangrene of the bone, *caries* as ulceration. In the former the mass of dead bone is separated from the living in the tissues by processes already described, and may remain as a foreign body; in the latter the process is one of molecular death, the débris of which is carried away by the fluid discharges. In necrosis the line of demarcation between the living and the dead tissue is well marked; in caries the bone is often honey-combed and the division between the living and the dead portions indistinct. The treatment of these conditions has already been described.

Sclerosis consists in a new formation of osseous tissue within the cancellous spaces and Haversian canals, resulting in an increased density of the bone and often a marked increase in its size. The process is a slow one, and is due to the presence of some chronic irritation or foreign body, as a tuberculous or syphilitic focus of inflammation, an area of necrosis, or an imbedded bullet. The condition is a symptom rather than a disease, as formerly supposed.

In the treatment of this condition an effort should be made to locate the irritating focus and remove it. For this purpose the use of the x-rays is often of great service.

Diffuse periosteal thickening is a condition often associated with the non-suppurating forms of osteomyelitis, especially those due to syphilis. The condition rarely gives rise to symptoms, and no treatment is required other than that addressed to the causative disease.

NUTRITIVE DISTURBANCES IN BONE.

The nutritive disturbances of the bony skeleton form an interesting but little understood group of diseases.

The present classification is the result of a number of excellent observations by accurate clinical observers, but without sufficient pathologic study to give us a comprehensive idea of the processes which result in the various clinical types of the disease.

In general it may be said that there are three classes of cases: First, those in which the chief pathologic condition is an overgrowth of bony tissue, with the various secondary changes and resulting deformities; second, those in which the chief factor is an atrophy of the bony tissues; and third, those in which the osteogenetic process is an irregular one.

In the first class will be found osteitis deformans, acromegaly, and leontiasis; in the second, osteomalacia and osteogenesis imperfecta; while in the third we may include chondrodystrophia and rachitis.

It is not improbable that further pathologic study will result in diminishing the number of individual diseases, as there is a noticeable similarity in the pathologic changes in the members of each class, the individual differences being largely in the location of the lesions and the age at which they appear.

Osteitis Deformans.

Osteitis deformans, first described by Paget, is a disease of adult life, characterized by a slow and painful enlargement of certain bones of the body. The changes in the bones consist in atrophy of the cancellous tissue, resulting in the formation of large medullary spaces and canals, with more or less softening and later hyperplasia of the compact tissue, increasing to a considerable degree the size of the bone. The disease attacks by preference the long bones of the skeleton, which may become curved by the weight of the body; also the cranial bones, the spine, and pelvis. Great thickening of the skull, curvature of the spine, and bow-legs are the chief deformities. The disease is progressive and is more frequent in men. While little is known regarding its etiology, it is almost always associated with an advanced degree of arterial sclerosis.

Symptoms.—The symptoms are early pain and discomfort in the affected bones; later, deformity and a characteristic attitude and gait. The head is bowed forward, the spine curved, the shoulders high, and the knees widely separated. The patient walks with a slow, waddling gait.

Treatment.—The treatment, up to the present time, has been absolutely unsatisfactory. Only hygienic measures are to be recommended.

Acromegaly.

Acromegaly is a chronic disease of the skeleton, characterized by progressive enlargement of the bones of the hands and feet, of the face, and often those of the trunk and extremities. The disease is, in all probability, due to some abnormality in the internal secretion of the pituitary gland, as it is often associated with new growth or other gross change in this structure.

Symptoms.—The symptoms begin, as a rule, in early adult life, and consist in deformities of the affected regions. The hands and feet enlarge, the under jaw becomes prominent, the nose and lips become thickened, and the eyebrows massive. The voice becomes coarse and deep in pitch. Later, a certain amount of mental sluggishness is apparent and the sexual function may be impaired. In some cases headaches are a prominent symptom. The prognosis is grave, but in many instances the progress is slow, and the duration of life may not be shortened.

Treatment.—The treatment in the past has been unsatisfactory. Cushing has recently advocated operative treatment, with a view to exposing the gland and removing any pathologic process found to be present. In April last he exhibited to the Society of Clinical Surgery a patient upon whom he had thus operated, with marked relief of symptoms.

Leontiasis.

Leontiasis is a progressive hypertrophy of the bones of the upper part of the face, giving rise to a peculiar lion-like countenance. The bone changes are similar to those of the preceding conditions and, in their development, often encroach upon the orbits, accessory nasal cavities, and foramina. In the latter situation, pressure upon sensory nerve trunks may give rise to neuralgic pains.

Treatment.—The treatment of leontiasis is undeveloped. The writer has, on two occasions, exposed and removed hypertrophied areas which were causing noticeable deformity. The appearance was temporarily improved, but the disease continued to progress.

Osteomalacia.

Osteomalacia is a rarefying degeneration of the bones of the skeleton, resulting in enlargement of the medullary spaces, replacement of the calcareous elements by a highly vascular fibrocellular tissue, and a thinning of the cortex. This results in softening, deformity, and a tendency to fracture on the slightest provocation. Little is known of its etiology, except that it is apt to follow multiple pregnancies in rapid succession. This has given rise to the theory that it may be due to an excess or a diminution of an internal secretion, possibly that of one of the sexual organs, or, as suggested by Bossi, of the suprarenal gland.

The early **symptoms** of the disease are pain in the affected bones, generally the pelvis, weakness, and a peculiar characteristic attitude and gait. The patient will bend forward and walk slowly with short steps, often supporting the body by leaning with the hands upon nearby objects.

The **treatment** should consist in the cessation of lactation, the administration of phosphates, cod-liver oil, and iron, with sea-bathing and other hygienic measures. Bossi and Rebaudi report a cure by the hypodermic injection of adrenalin.

Osteogenesis Imperfecta.

A congenital condition similar to osteomalacia, resulting in atrophy of the bony cortex and extreme fragility of the bones.

The children, as a rule, are undersized at birth, may be deformed (short legs), and are often mentally deficient. Fractures occur on the slightest violence; not infrequently one or more bones are broken at the time of birth. There is no satisfactory treatment for this condition.

Chondrodystrophia.

Sometimes called congenital rickets. A rare condition of malnutrition during intra-uterine life, resulting in an arrest of development of the long bones, particularly those of the lower extremities. Most of these children are stillborn. When they survive they are dwarfed, with bow-legs, short, curved arms, and sunken noses. They generally exhibit also a peculiar deformity of the hands, called by the French *Main-en-trident*, in which the entire hand is shortened and the fingers all about the same length. The spine is frequently curved, the abdomen prominent, giving the deformity described as spondylolisthesis.

Rachitis.

Rachitis is a constitutional disease, which may rarely be congenital, but is generally due to defective nutrition during infancy, resulting in delayed calcification of the bones, faulty epiphyseal growth, and various deformities of the skeleton. Erichsen has described the condition as follows: "The essential features of the process are, first, an exaggeration of the processes immediately preparatory to the development of new bone; secondly, an imperfect conversion of the preparatory tissue into true bone; and thirdly, a great irregularity of the whole process." There are thickening and deformity of the epiphyseal cartilages, thickening and hyperæmia of the periosteum, enlargement of the medullary spaces, and a condition of sponginess and hyperæmia of the cortex.

The early **symptoms** of rachitis are digestive disturbances, flatulence, diarrhœa or constipation, sweating about the head when asleep, delayed dentition, delayed closure of the fontanelles, and delayed walking. The deformities consist of enlargements at the epiphyseal junctions, chiefly observed on the thorax at the points of union of the ribs and costal cartilages (rachitic rosary), at the lower extremity of the tibia, and lower extremity of the radius; irregularities in the outline of the skull, which may be shortened anteroposteriorly or elongated; the forehead is often flat, high, and square, with or without supra-orbital bosses; the thorax and pelvis are deformed; there is curvature of the long bones, especially of the lower extremity, which is generally the result of bending from too early attempts at walking, or from faulty postures or muscular traction. There are enlargement of the abdomen, and a bulging of the lower ribs, giving rise to an apparent constriction opposite the attachment of the diaphragm (Harrison's sulcus). Rachitic children who walk frequently suffer from antero-posterior or lateral curature of the spine, from bow-leg, knock-knee, and flat foot.

The **treatment** of rachitis in the early stage should be to give the best possible diet, which should always include orange-juice and meat broths; to administer iron, cod-liver oil, and phosphorus; to give daily salt baths and general massage; and to keep the child as much as possible in the open air and sunshine. Efforts at walking should be discouraged until the nutritive disturbances have been corrected. In the early stage of bony deformity, when the bones are soft and yielding, much may be accomplished by manipulation, braces, and plaster casts, especially in deformities of the extremities. At a later period osteotomy or osteoclasis may be necessary.

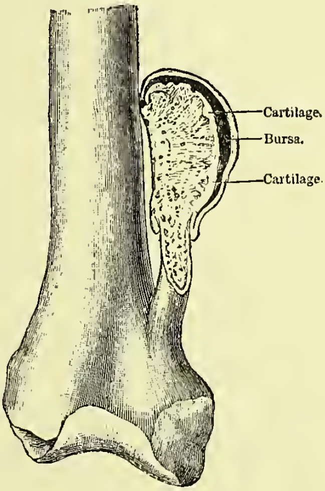
TUMORS OF BONE.

Osteoma.

Osteomata, or bony tumors, are, as a rule, either calcified chondromata or bony outgrowths at points of attachments of muscles; the former occur in the long bones at or near the epiphyseal lines or in the flat bones in the neighborhood of cartilaginous tracts, and are generally connected with the bone by a plate of cartilage; the latter are frequently found arising from the adductor tubercle of the femur or from other points of muscular attachment, are often surrounded by a cartilaginous capsule, and are occasionally covered by bursæ.

Osteomata are slowly growing tumors, which, however, may reach an enormous size. They are innocent in character, and only produce pain and other disturbances by pressure on neighboring structures.

Fig. 289.



Exostosis of femur: its surface was clad with cartilage and surmounted by a bursa. (Orlow.)

Chondroma.

Chondromata, or cartilaginous tumors, are frequently encountered growing from the long bones, generally from the neighborhood of an epiphyseal line. They are encapsulated, and often occupy hollowed-out spaces in the bone. These tumors are most frequently seen growing from the small bones of the hand, and are commonly multiple (Fig. 290). They may reach a large size and cause much discomfort. They are always innocent, but should be removed if they produce inconvenience. Chonromata may rarely develop in the interior of the large bones in the majority of instances at or near the epiphyseal line. Here they may expand the cortex and give rise to symptoms and signs closely resembling medullary sarcoma. Myxomatous degeneration may occur and give rise to a bone cyst.

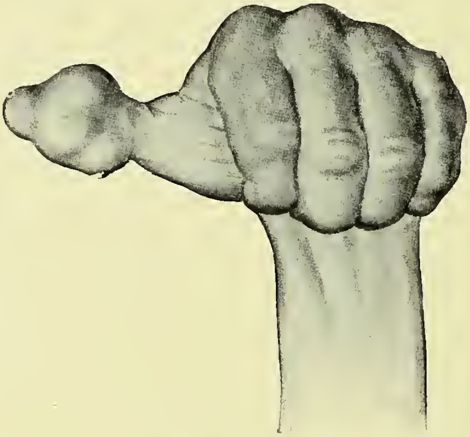
Fibroma and Lipoma.

Fibromata and lipomata are occasionally found growing from the periosteum, but differ in no respect from similar growths in other tissues.

Bone Cysts.

Bone cysts may arise from trauma, resulting in an hæmatoma, which later forms a cyst as in other tissues ; from an infection by the tænia echinococcus, giving rise to single or multiple hydatid cysts ; to myxomatous degeneration of a chondroma (Fig. 291), or to cystic degeneration of a sarcoma. The sarcomatous cysts may or may not exhibit typical sarcomatous tissue on the interior of the bony cavity. In one case observed by the writer the cavity seemed, on macroscopic examination, to be lined with only a thin layer of granulation tissue and to contain a blood-stained fluid. Microscopic examination, however, showed the lesion to be mixed-cell sarcoma. In cystic disease the bone is generally enlarged and the cortex often markedly atrophied, giving rise to the egg-shell sensation on palpation. This, with the similar circumscribed light area in an x-ray plate, will often lead to the diagnosis of a solid tumor of bone, from which the cases are with difficulty differentiated.

Fig. 290.



Chondroma of hand.

Treatment.—The treatment consists in freely opening the cyst, removing all diseased tissue to normal vascular bone, and treating the cavity as those resulting from osteomyelitis. If the disease is proved to be sarcoma, amputation should be performed in all but the giant-cell variety.

Malignant Tumors of Bone.

All primary malignant tumors of bone are of mesoblastic origin; the carcinomata occur only as secondary metastatic deposits.

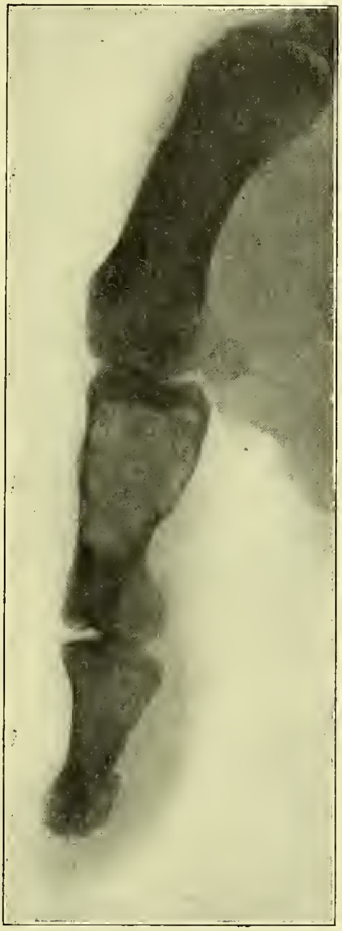
Sarcoma.—Sarcomata may arise from the periosteum and gradually extend around the bone; or they may develop from the cancellous tissue of the medullary canal and by their growth expand the cortical shell. The former are called *peripheral* or *periosteal sarcomata;* the latter, *central* or *medullary sarcomata.*

Periosteal sarcomata are more frequent in the diaphyses of the long bones, and by their growth develop around the shaft, which may be seen by the x-rays to present a fairly normal appearance in the centre of the tumor. In central sarcomata the growth distends the bone often to an enormous size, and the surrounding capsule of compact tissue may become so atrophied as to give to the examining hand the sensation of a crackling egg-shell. On x-ray examination the fusiform dilatation of the cortex can be readily made out. Periosteal sarcomata are most frequently of the round-cell variety; they often follow an injury, grow rapidly, and are extremely malignant. Less frequently they are made up of spindle or giant cells and are less malignant. They commonly present, in their interior, bony trabeculæ growing at right angles to the shaft.

Central sarcomata are most frequently of the myeloid type. They develop commonly in the ends of the long bones or in the horizontal ramus of the mandible, grow slowly, and are the least malignant of all the sarcomata. Less frequently the round-cell or mixed sarcomata are found developing from the centre of the bone; generally, however, from the shaft.

Sarcomata apparently occur in the bones most liable to injury; thus, of the long bones, the femur, tibia, and humerus are the ones in which the disease is most frequently encountered; next in frequency come the radius, ulna, and clavicle. Of the other bones, the superior and inferior maxilla, the ilium, and spine are fre-

Fig. 291.

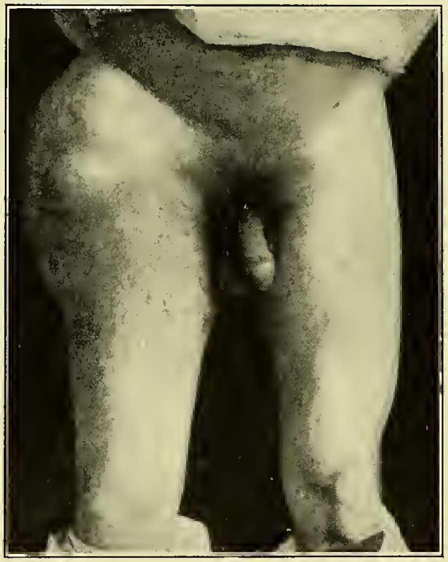


Radiogram of chondroma of bone.

quently the seat of the disease. In the long bones the disease is generally located near an active epiphysis, as the lower extremity of the femur or radius, and the upper extremity of the tibia or humerus.

Endothelioma.—Volkmann, Hildebrandt, and others have called attention to a class of tumors which arise from the endothelium of the bloodvessels and lymph-spaces. While possessing many of the clinical characteristics of sarcoma, they frequently differ from the sarcomata in that they occur at a later period of life, are often highly vascular, are sometimes accompanied by pulsation and a bruit on auscultation, giving rise to the term *aneurism of the bone.* Spontaneous fractures are rather more frequent in endotheliomata than in the other tumors of bone.

Fig. 292.



Sarcoma of femur.

Diagnosis.—The diagnosis of bone sarcoma in the early stage is often impossible, the chief difficulty being in excluding chronic osteomyelitis, gumma, and, when the disease is located in the extremity of a bone, chronic disease of the joint. The two chief symptoms are pain and tumor. Gross stated that pain is the initial symptom in two-thirds of the cases, tumor, in one-third. In the writer's opinion these figures should be reversed, as a tumor is often present when the patient first complains of pain, although unnoticed up to that time. Regarding rapidity of growth there is much variation. The giant-cell or mixed-cell tumors develop very slowly, several years often elapsing before much inconvenience is produced. In the small round-cell tumors and in some of the vascular endotheliomata the growth is exceedingly rapid. The occurrence of a progressively growing tumor of a long bone without fever, or serious impairment of the function of the limb, is strongly suggestive of sarcoma. If aspiration fails to reveal the presence of pus, the probability of sarcoma is increased. If there is, in addition, the presence of the "egg-shell crackle," or an absence of joint-symptoms in tumors situated near an articulation, and if the *x*-rays show the tumor to surround the shaft of the bone or to expand the cortical portion, the diagnosis may be said to be certain. In all doubtful cases, however, an exploratory incision and the removal of a section of the tumor for microscopic examination is indicated.

Prognosis.—With the exception of myeloid or giant-cell sarcomata, the prognosis in malignant disease of bone is exceedingly grave. While McCosh has reported 3 out of 7 cases of sarcoma of the femur, treated by hip-joint amputation, well from 4½ to 12 years after operation, few such favorable statistics have been recorded. The majority of writers who have collected large series of cases, as Gross, Butlin, and Coley, state that the number of permanent cures is exceedingly small. In giant-cell sarcoma the outlook is comparatively favorable, as these tumors apparently do not give rise to metastases, and early and complete removal of the original focus will generally be followed by a permanent cure.

The **treatment** of bone sarcoma depends largely on the nature of the growth. In all but the myeloid variety amputation should be practised sufficiently far above the disease, if situated in an extremity, to insure removal of the entire bone and surrounding tissues. Thus in sarcoma of the bones of the leg, amputation at the knee-joint or lower third of the thigh is to be advised. In disease of the lower extremity or shaft of the femur, the amputation should be at the hip-joint. In rapidly growing sarcoma of the upper extremity of the femur, operation is inadvisable. Sarcoma of the bones of the forearm should be treated by amputation just above the elbow-joint; those of the shaft and lower extremity of the humerus, at the shoulder-joint; those of the upper extremity of the humerus should be treated by removal of the entire shoulder-girdle. This has been the recognized practice in the past.

Quite recently Cavaillon and Alamartine have advocated more limited operations, on the ground that in the great majority of instances the disease extends by direct prolongations from the original growth rather than by the carrying of fragments to distant parts of the bone by the circulating fluids. In support of this view they quote a large series of cases observed for a number of years in which a greater number of three-year cures were obtained by the less mutilating operations. The subject is deserving of further study. If the tumor is of the myeloid variety, all surgeons now agree that the entire extremity need not be sacrificed, but the diseased portion of the bone may be removed, or the limb just above the lesion. In myeloid sarcoma of the lower jaw a bridge of bony tissue should be left to prevent deformity.

Inoperable, recurrent, and secondary sarcoma of bone may be treated by the Coley fluid of the mixed toxins of Streptococcus erysipelatis and Bacillus prodigiosus.

There is of late a growing tendency among surgeons, even in the operative cases, to resort to the use of Coley's toxines immediately after operation. The results which have followed this method of treatment, as recently reported by Coley, certainly show an improvement over the treatment by operation alone.[1]

Multiple Myeloma.—A disease characterized by multiple myeloid tumors in different bones of the skeleton, always associated with the presence of albuminose in the urine. The tumors rarely grow to a large size, but occasionally give rise to pressure symptoms, particularly of the brain and spinal cord. Another symptom produced by this disease is an abnormal fragility of the affected bone, often resulting in spontaneous fracture. As one cannot hope to remove all of the diseased areas, the only treatment at present advised is to remove those tumors producing pressure symptoms.

Carcinoma.—Carcinoma of bone occurs only as a secondary deposit. As its occurrence under these circumstances is an evidence of general infection, no treatment is advisable.

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[1] Coley, Surgery, Gynæcology, and Obstetrics, Feb., 1908.

CHAPTER XXVI.

INJURIES AND DISEASES OF THE JOINTS.

Contusions.

CONTUSIONS in the neighborhood of joints are of frequent occurrence from all manner of traumata. They are accompanied by superficial ecchymoses, and occasionally by deeper extra-articular hæmatomata and hemorrhages into the synovial sacs. In the superficial joints, as the knee, elbow, wrist, and ankle, the injuring force may be so directed as to cause a bruising of the synovial membrane, which gives rise to an acute and often sickening pain, which soon disappears unless the trauma causes injury to the ligaments or tendons or results in synovitis. In the majority of cases no treatment is required other than temporary rest of the articulation and the application of a firm bandage.

Sprains.

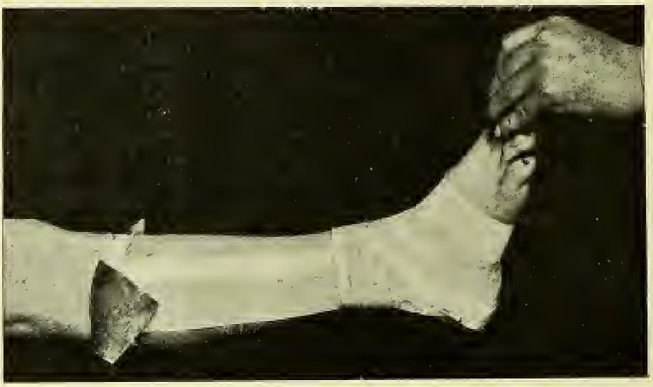
The term sprain is used to include a class of injuries somewhat similar in character to the preceding, but in which there occurs, in addition, a rupture, or at least a severe stretching of the ligamentous structures, muscles, or tendons, which support the joint. These injuries in the majority of instances are produced by a severe wrench or twist of an articulation, which if continued would result in dislocation or fracture. The ankle and wrist, on account of their frequent exposure to such injuries, are the joints most likely to be the seat of sprain. After these injuries there is usually a rapid swelling of the tissues in the neighborhood of the joint, due to effusion of blood from the torn vessels into the extra-articular structures, and often into the joint-cavity as well. This is followed later by a non-infectious inflammatory reaction, which results in a temporary œdema and fibrinous exudate into the subcutaneous cellular tissue, muscles, tendon-sheaths, ligaments, and synovial membrane, and not infrequently an effusion into the synovial sac.

The **symptoms** of a sprain are acute pain experienced at the moment of injury, which may be so severe as to preclude the possibility of using the extremity for several hours or days. In other cases the pain subsides after a few moments, but reappears on any attempt to move the joint or use the extremity. The joint appears swollen and is tender to the touch, the points of maximum tenderness corresponding to the location of the ruptures of the peri-articular tissues or to the subsequently developed hæmatomata. As soon as the reactionary inflammation appears there are heat in the joint, increased tumefaction, often redness, and a greater amount of tenderness and pain on motion. Ecchymoses appear and fluctuation may often be appreciated.

These symptoms may continue for a variable period, depending on the extent of the original injury or the treatment received. In a certain number of cases, even under the most approved methods of treatment, persistent pain on motion and areas of tenderness will remain long after the swelling has entirely subsided. In these cases there is generally present either an unrecognized fracture, a subacute synovitis, or, in the case of the ankle, a breaking down of the arch of the foot, with muscular spasm.

Treatment.—When possible, immerse the injured part in a pail of hot water, and then gradually add hotter water until the temperature is as high as the patient can bear. The joint should then be bandaged as tightly as possible without causing pain—a rubber or flannel bandage being used. The first effect of the heat is to diminish the pain and to contract the vessels, thereby limiting the hemorrhage and serous effusion. The use of the elastic bandage applied immediately after removal of the limb from the hot water serves to prevent subsequent congestion and exudation. Absolute rest of the joint should be advised, and, if comfortable, the bandage should be allowed to remain in place for two or three days.

Fig. 293.



Adhesive plaster strapping applied for sprain of the ankle. (Whitman.)

When the first bandage is removed, the joint should be strapped with adhesive plaster, as suggested by Gibney and shown in Fig. 293. This prevents swelling and gives sufficient support to the parts to enable the patient to use the limb moderately without discomfort.

In the majority of instances, however, the surgeon is not called until inflammatory reaction has appeared, and the joint is in a condition of acute hyperæmia and œdema. In these cases, rest in bed with hot fomentations or a wet dressing of aluminium acetate is to be recommended for a few days until the inflammatory symptoms have disappeared, after which a light plaster cast may be applied and the patient be allowed to go about on crutches. In all cases of sprain, especially those occurring at the ankle or wrist, great care should be exercised by the surgeon positively to exclude the presence of fracture, for no mistake is more easily made or more harshly criticized. If necessary, the joint should be examined under general anæsthesia or by the *x*-rays.

Penetrating Wounds of the Joints.

These accidents are rare except as a result of severe traumata, gunshot or stab wounds. While the smaller joints may occasionally be opened, and the untoward results be limited to a slow process of healing, and perhaps a permanent anchylosis, wounds of the large joints are often followed by loss of the limb or the life of the patient. This is particularly true of the knee-joint, the synovial membrane of which is justly regarded by surgeons as one of the most vulnerable tissues of the body to septic infection, and, on account of its peculiar shape and anatomic relations, is, of all the joints, the one most difficult to drain and to successfully disinfect. Moreover, there seems to be from the synovial membranes of the larger joints a greater amount of septic absorption than from any other tissue of equal size and vascularity. From what has been said, it will appear that the danger of these injuries is solely from sepsis, and the treatment, therefore, should consist in measures to prevent or combat infection.

The **symptoms** of a penetrating wound of a joint are, in addition to the visible signs of a wound which might open the synovial cavity, the presence of a flow of synovia from the cutaneous opening. This is a clear syrupy fluid, which is fairly abundant from the large joints, and may be tinged with blood. A similar fluid may appear in such a wound from an injured extra-articular bursa; but in these cases the fluid is, as a rule, less abundant. Inspection will occasionally reveal the presence of the exposed glistening white articular cartilage in the bottom of the wound. Pressure over uninjured portions of the joint-sac will sometimes result in the appearance in the wound of an increased amount of fluid blood or synovia. In many cases the diagnosis can only be made by the probe; which, however, should never be employed except under conditions of strict asepsis.

Treatment.—In all cases of suspected wound of an injured joint an antiseptic dressing should be immediately applied and the patient removed to some place where an aseptic examination can be made. If the conditions are such that an aseptic exploration cannot be carried out, it is wiser to allow the wound to heal as quickly as possible under the primary dressing, in the hope that infection has not occurred, or that the resistance of the individual is sufficient to cope with it without assistance, and to interfere only in case evidences of sepsis appear. In addition to the primary dressing, the limb should be immobilized and the patient placed in bed. The bowels should be freely moved, and diuresis favored by copious draughts of pure water to assist in elimination of any toxins that may develop. If evidences of septic arthritis appear, it should be treated in a manner presently to be described. If the conditions are such as to insure an aseptic examination of the wound, the surgeon should first pack the external wound with sterile gauze, then shave and scrub the neighboring parts, after which the packing should be removed and the cutaneous wound thoroughly disinfected with hydrogen peroxide, formalin solution, or mercuric chloride (1 : 1000), after which a probe may be cautiously employed. If the wound is found to penetrate the joint-cavity, it should be sufficiently enlarged to allow thorough irrigation of the sac with sterile salt solution. The wound should then be partly closed, a rubber tube or gauze drain being left in the joint-cavity, and a bulky aseptic dressing applied.

If the wound remains aseptic, the dressing should not be changed for a week or ten days. If infection occurs, the case should be treated as one of septic arthritis.

INFLAMMATORY DISEASES OF THE JOINTS.

Synovitis.

There is a growing tendency among surgical writers to limit the use of the term inflammation to those pathologic processes which are accompanied by infection. This would logically exclude simple traumatic synovitis from the class of inflammatory diseases, for the reason that the tissue-changes observed in such a condition are of the same general character as those present after contusions or sprains, and are, in fact, the ordinary processes of repair. If, however, we are to regard inflammation as "an effort on the part of the animal organism to rid itself of an irritant," all such reparative processes should be considered inflammatory. For the present, at least, it seems desirable to classify acute non-infectious synovitis as an inflammatory disease.

Acute serous synovitis may be caused by trauma, resulting in injury to the synovial membrane ligaments or cartilages, and often associated with hæmarthrosis, the presence of a foreign body in or near the joint; by the presence of a neighboring focus of infection, which frequently occurs in the articular extremities of the bones; or by some general infectious disease which gives rise to joint irritation in various parts of the body. The synovial membrane is congested, thickened, and infiltrated with round cells. An exudate occurs into the joint-cavity which may be serous in character, mixed with blood, or it may contain flakes of fibrin or be cloudy from the presence of leucocytes and cast-off endothelial cells.

Under ordinary circumstances, if the joint is at rest, these conditions gradually disappear and the joint structures take on a normal appearance. If, however, the joint is irritated by constant use, repeated traumata, or by the presence of a movable cartilage, the synovial membrane may become permanently thickened and the joint effusion persists, constituting the condition known as *chronic serous synovitis* or *hydrops articulorum.*

The **symptoms** are those of any local inflammation: pain, heat, swelling, impairment of function, and occasionally redness of the skin. The pain is always increased by motion and may be absent if the joint is at rest. The swelling is due to distention of the synovial sac with serum, which causes obliteration of the normal outlines of the joint, and in superficial joints may give rise to fluctuation. There is, as a rule, no fever or other evidence of general reaction or infection in the traumatic cases; in those due to a general or a neighboring focus of infection, however, fever and other evidences of toxæmia may be present, but these symptoms are due to the infective focus rather than to the secondary synovial lesion.

Treatment.—The treatment should consist in rest on a splint, cold applications for the relief of pain, and later massage, hot and cold douches, moderate functional use, and the application of pressure by means of an elastic bandage. If the case can be seen early, before an exudate has appeared, or at a later period, after the exudate has subsided, strapping the joint will allow moderate use without discomfort.

Early aseptic aspiration and the immediate application of an elastic bandage are recommended by many surgeons, who claim for this method of treatment a considerable shortening of the period of confinement. In acute synovitis of a large joint the prognosis should always be guarded, for if the joint is irritated by continued use after receipt of the injury a protracted and perhaps permanent impairment of function may result.

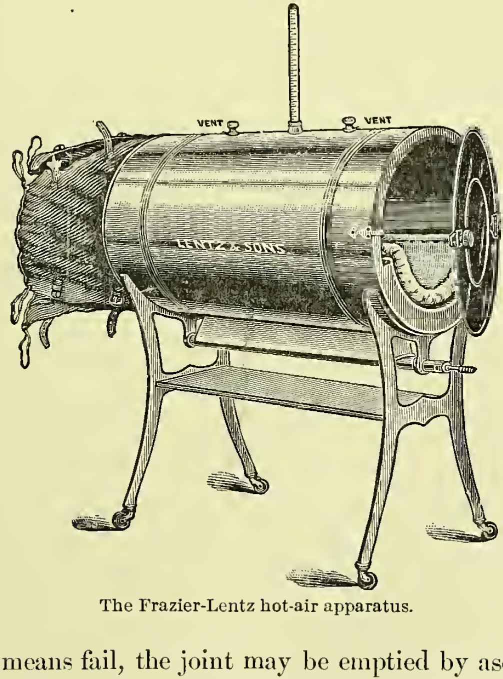
Chronic serous synovitis generally results from a neglected acute synovial inflammation, the presence of an injured or movable cartilage, blood-clot, foreign body, or thickened synovial fringe within the joint; and is characterized by the presence of a chronic effusion into the synovial sac which shows little tendency to absorb. There is, as a rule, no pain, tenderness, or marked limitation of motion, and, aside from a slight weakness and instability of the limb, no inconvenience is noticed.

The **diagnosis** is established by demonstrating the presence of an abnormal amount of fluid in the synovial cavity. In the joints which are so located that the synovial membrane is near the surface, fluctuation is generally easy to appreciate, although a greatly distended synovial sac may occasionally give to the examining hand the sensation of a solid elastic tumor. In the deeper-seated joints one must be guided by the appearance and location of the swelling, the position of the extremity, and the impairment of function. Aspiration is often necessary to demonstrate the presence of fluid in these cases.

Signs of Effusion into the Larger Joints.—In the *shoulder-joint* there is a general swelling of the region of the articulation, which lifts the deltoid muscle and may be felt in the axilla. It is distinguished from the swelling due to inflammation of the subdeltoid bursa by the fact that in the latter condition the bursal swelling is limited to the space beneath the centre of the muscle and cannot be felt in the axilla, whereas in joint-effusion the swelling extends to or beyond the anterior and posterior borders of the muscle, and is especially noticeable along the bicipital groove. In the *elbow-joint* an effusion causes a bulging posteriorly on either side of the olecranon and triceps tendon. Inflammation of the olecranon bursa gives rise to a fluctuating swelling *over* the olecranon. In the *wrist-joint* there is a general tumefaction both in front and behind, which lifts the tendons and is sharply limited above and below by the radiocarpal and the carpometacarpal joints. Inflammation of the common flexor tendon bursa causes an hour-glass swelling on the flexor surface of the wrist, above and below the annular ligament. Effusion into the *hip-joint* causes a fulness about the joint which is most noticeable in the post-trochanteric region and in the upper part of Scarpa's triangle. The limb is partly flexed, abducted, and everted. Iliobursitis causes a swelling on the inner aspect of the thigh *only*, and in gluteal bursitis the swelling is limited to the buttock. In the *knee-joint*, the effusion causes obliteration of the normal depressions on either side of the patella and its tendon. The swelling is especially marked above the patella as an oval fluctuating tumor which may extend upward on the thigh for two or more inches. The patella floats, but can be made to strike the condyles by quick, firm pressure. These signs are absent in prepatellar bursitis, in which case the fluctuating swelling lies over and below the patella. In pretibial bursitis the swelling bulges the space on either side of the patellar ligament, is triangular in shape with the base directed upward and the apex pointing to the tubercle of the tibia. In the *ankle-joint* the effusion bulges and effaces the normal depressions situated between the malleoli and the tendo Achilles. The flexor tendons are raised from the bone and fluctuation can generally be detected.

The **treatment of chronic serous synovitis** consists in rest, counterirritation, massage, hydrotherapy, compression, and the use of hot-air baths. Counterirritation is produced best by the application of the actual cautery, fly blisters, or painting with iodine ; compression by the use of the rubber bandage or an elastic stocking or cap ; the hot-air bath requires a special apparatus, which is pictured in Fig. 294).

Fig. 294.



The Frazier-Lentz hot-air apparatus.

If these means fail, the joint may be emptied by aseptic aspiration and immediate compression applied by a rubber bandage, or open arthrotomy may be performed for purposes of exploration. This treatment should be followed by a period of rest of from two to three weeks.

Arthritis.

By common consent the term arthritis refers to those inflammations of the joints which are apt to involve more than the synovial membrane. It includes, therefore, practically all forms of joint-inflammation other than those just described as simple acute and chronic synovitis. The disease may be caused by septic infection, by rheumatism, by gout, by syphilis, or by tuberculosis. As these forms of arthritis differ so markedly in their clinical history, treatment, and results, they will be considered separately.

Acute Septic Arthritis.—The disease may be caused by a primary lesion of the synovial membrane, or the original septic focus may be located in the bone (acute septic epiphysitis), and subsequently rupture into the synovial cavity. The type of the former variety would be the septic arthritis which follows a penetrating wound; that of the latter, the joint-infection which occurs secondarily to an acute osteomyelitis. In both of these varieties the inflammation is accompanied by pyarthrosis. Purulent arthritis not infrequently results from metastatic accidents during the progress of some grave septic disorder. In these cases several joints are apt to be involved. There is another variety of septic inflammation of the joints, and that is a non-suppurative form which occurs during the progress of some severe general infectious disease, and is presumably due to the irritation of certain toxic substances contained in the blood. It constitutes one of the varieties of the so-called gonorrhœal rheumatism, is occasionally observed during the acute exanthemata, and there is reason to believe that the joint lesions of acute articular rheumatism belong to this class. In the purulent cases, if the inflammation begins in the synovial membrane, this becomes congested, thickened, and infiltrated with round cells. The process rapidly extends to all parts of the joint cavity and to the peri-articular structures as well. Hemorrhages and areas of necrosis occur, especially in the severer infections, and the cartilages may become eroded and destroyed. The effusion takes place rapidly, and is at first cloudy and filled with fibrinous particles; later, it is frankly purulent. With the local process there is associated a general toxæmia that may develop into an acute septicæmia, or the infection may be carried by the blood-current to other points and the patient succumb to pyæmia.

If the disease begins in the bone, the infecting micro-organisms are generally deposited in the spongy, cancellous tissue of the epiphysis immediately below the articular cartilage. The process is the same as in other varieties of septic osteomyelitis. The necrosis may be limited to a portion or it may involve the entire epiphysis. As a rule, there are signs of irritation of the synovial membrane before the bone abscess ruptures into the joint. After infection of the synovial membrane occurs, however, the process is the same as the variety just described. The disease in the majority of instances is due to the staphylococcus, the streptococcus, the gonococcus, the pneumococcus, or to the typhoid bacillus. In the majority of cases it occurs in the hip or the knee.

Arrest in the growth of the bone is to be expected if the epiphysis is destroyed. In the non-suppurating variety there is a moderate scrofibrinous exudate with considerable peri-articular œdema. Where the joint effusion is small or absent, the disease is spoken of as *dry septic arthritis*, and is frequently followed by an exceedingly obstinate form of fibrous anchylosis.

Symptoms.—The disease may be ushered in by a chill; generally, however, there is localized pain followed by a gradual rise in temperature, rapid pulse, prostration, and general malaise. If the disease begins as an acute epiphysitis, which is frequently the case in infants, there is apt to be severe pain for several days before the joint-effusion appears. When this occurs the joint becomes hot, red, and exceedingly tender, motion is restricted by muscular spasm, fluctuation is present, and symptoms of grave sepsis develop rapidly. The abscess may rupture spontaneously and recovery may take place, or prolonged suppuration may follow the spontaneous evacuation or opening of the abscess, due to the presence in the joint of the necrosed fragment of the epiphysis. In the non-suppurative variety, several joints are, as a rule, involved; and while there may be redness, swelling, and pain in each, the local symptoms are by no means so severe as in the suppurating variety, and fluctuation is rarely well marked. When the disease is secondary to some other septic process the symptoms may be masked by those of the original infection, and the joint-lesion may be overlooked.

Treatment.—In all save the non-suppurating cases, the treatment should be by incision, irrigation, and free drainage. Several incisions should, if necessary, be made into the joint to insure thorough drainage. The synovial sac should be irrigated with 1 to 100 formalin, after which it should be flushed with a large amount of sterile salt solution; drainage-tubes should be introduced and the joint kept at rest by means of a splint or starch bandage, and elimination of the toxins favored by free catharsis, diuresis, and the ingestion of a large amount of water and fluid food. In cases of extreme sepsis, stimulants, intravenous infusions, and rectal irrigation should be freely employed. If these measures fail to arrest the local infection, the joints should be freely opened and packed as suggested by Mayo. Amputation occasionally may be required to save life.

Mayo's operation, which was originally designed for the treatment of septic arthritis of the knee, consists in a semilunar incision from one condyle to the other across the front of the joint through the patellar tendon. When the joint is freely opened by this method the leg is acutely flexed, the crucial ligaments severed, and the capsule sufficiently divided to expose freely every recess of the synovial membrane. The parts are then thoroughly cleansed, the leg fixed in the flexed position by suitable apparatus, and the exposed joint-surfaces packed with wet bichloride or formalin gauze. Improvement in the general septic symptoms almost invariably follows this procedure if carried out before a blood infection has occurred, but many weeks are sometimes required before all evidences of sepsis have subsided. After convalescence from the infection is thoroughly established, the ends of the bones should be excised, all necrosed portions of the cartilage removed, and the leg extended and firmly fixed by a posterior splint or plaster cast. The skin flaps can generally be easily approximated after excision of the bones, and should be held together with one or two sutures, the rest of the wound being left freely open for drainage. Bony union eventually takes place, and a useful but stiff limb will result.

In the non-suppurative cases an effort should be made to subdue the original source of infection wherever located, and the usual treatment for acute synovitis employed.

Gonorrhœal Arthritis.—Although this disease is in reality a variety of acute septic arthritis, it occurs so frequently and in so many different forms that a separate consideration of some of its features is desirable.

The affection rarely appears during the acute stage of the disease, but may occur at any time during the existence of the urethral infection. The joints most commonly affected are, in the order of their frequency, the knee, ankle, tarsus, wrist, elbow, and shoulder. The tendon-sheaths of the ankle and wrist are also often involved in the process. In the majority of instances more than one joint is affected in the beginning, but as the disease progresses usually one of the joints becomes more inflamed than the others, and remains for a varying period more or less acutely infected, after the others have returned to their normal condition.

Several clinical types of the disease are encountered. In the mildest of these there is simply slight soreness or stiffness of one or more joints, which appears and disappears suddenly, and rarely gives rise to much inconvenience. In other cases the same condition may arise in connection with fever, rapid heart action, and general malaise. In the severer cases the condition may closely resemble that of acute articular rheumatism, except that it is wholly uninfluenced by antirheumatic treatment; or the disease may be limited to a single articulation which may become exceedingly painful, red, and tender to the touch. An effusion may take place into the synovial pouch, which may be serofibrinous, seropurulent, or purulent in character. It may be sterile or contain gonococci or other pyogenic micro-organisms. In other cases the peri-articular fibrous structures are chiefly involved. The disease shows little tendency to erode or destroy the cartilages, but there seems to be in many cases an excessive development of granulation tissue within the synovial cavity, which gives rise to a bogginess of the joint, and later exhibits a strong tendency to obstinate fibrous anchylosis.

The symptoms of gonorrhœal arthritis in its milder form correspond with those of simple synovitis; in its severer type, to those of septic arthritis.

The *treatment* in the milder cases consists in rest, the application of heat by means of fomentations or baking, and measures to combat the original source of infection. At a later period, when the acute symptoms have subsided, massage and passive motion are to be employed. The occurrence of an effusion in the presence of septic symptoms demands an exploratory aspiration; and if pus is present, incision and drainage in the manner already described. If this is carried out at an early period, the prognosis for a complete restoration of the joint function is favorable. In certain cases, however, particularly of the subacute type, improvement is slow and frequent relapses occur, often prolonging the treatment for many weeks or months. In these cases the Bier hyperæmic treatment, the use of antigonococcic serum, or increasing the opsonic index of the patient by repeated vaccinations often will be followed by rapid improvement.

Chronic Non-tuberculous Arthritis.—During the past few years much has been added to our knowledge of the various types of chronic joint disease by painstaking pathologic observation; and while the anatomic changes in these joints have been clearly and accurately classified, it has not been found that the different pathologic lesions correspond with any definite clinical types of disease. Nichols and Lovett, in an examination of a large number of cases of chronic non-tuberculous joint-disease, found practically the same anatomic lesions in all, and have arranged them in five groups: First, cases in which there is present an increased amount of synovial fluid; second, those in which ulceration and destruction of the articular cartilages constitute the chief lesion; third, cases exhibiting anchylosis, fibrous, cartilaginous, or bony; fourth, the formative type, where there is an excessive formation of new bone arising either from the periosteum around the periphery of the articular cartilage, or from the endostium beneath the cartilage which has been exposed by ulceration; and fifth, the fungous or villous type, in which there is present an overgrowth of the synovial membrane in the form of granulation tissue, papillary masses, or cartilaginous tags. The latter may become detached from their original points of origin and lie free in the joint cavity, forming the so-called *joint mice.* Regarding the etiology of these conditions little is definitely known except that there must be present some form of chronic irritation. Various theories have been suggested, each of which may explain a certain number of cases, but it is improbable that any one etiologic factor will be found which can account for all. Of the various causative conditions may be mentioned trauma, bacterial infection of a low grade of virulence, errors in metabolism, and organic lesions in the central nervous system.

The following clinical types are the ones most commonly encountered, in each of which any or all of the above-mentioned lesions may be present, but some one of which is apt to predominate.

Rheumatic Arthritis.—In addition to the joint manifestations of acute rheumatic fever, which have been alluded to under Acute Septic Arthritis, there occurs a subacute and chronic arthritis which is apparently rheumatic in character. This may take the form of a chronic synovitis or a chronic peri-articular thickening, or of both combined, with more or less limitation in motion. The tendency in these cases, according to Bradford and Lovett, is "away from suppuration and toward connective-tissue formation." They are greatly improved by antirheumatic treatment, hydrotherapy, and massage.

Gouty Arthritis.—True gout attacks by preference the metatarsophalangeal joint of the great toe and the joints of the hand, rarely the knees, elbows, or other large joints. It is caused by the formation of crystals of sodium urate both in the synovial membrane and in the extra-articular fibrous tissues. This gives rise to a more or less acute inflammation of the joint, which is often followed by considerable thickening and ulceration of the cartilages with fibrous or bony anchylosis. The treatment is medical, combined with baking, hydrotherapy, massage, and diet.

Arthritis deformans, or *rheumatoid arthritis,* is "a chronic disease of the joints characterized by changes in the cartilages and great deformity" (Osler). The disease is, in all probability, of neuropathic origin, as the changes are trophic rather than inflammatory. It occurs as a monarticular or polyarticular affection. The synovial membrane is thickened, the cartilage fibrillated and disintegrated, new bone-formation replaces the destroyed cartilage, causing elevations and depressions on the articular surfaces, peripheral exostoses, and great deformity. The ligaments become relaxed and calcified, the muscles atrophy, and the joint-function is greatly impaired. The disease may be limited to the small joints of the hands or feet, but it often affects the knees, ankles, elbows, wrists, and shoulders. Occasionally it is limited to the hip or spine in elderly people.

Symptoms.—In young people, especially women, arthritis deformans may occur as an acute polyarticular disease. There is pain in the affected joints, with effusion and some fever. The disease often subsides and recurs at frequent intervals. Gradually the effusion is absorbed and the joint becomes dry and crepitates on motion. In the majority of instances, however, the disease is afebrile. Pain and stiffness are the chief symptoms, the former occurs, as a rule, only on motion, the latter is noticed more in the morning and on using the joint after a period of rest. Fever is rarely present, but may occur during an exacerbation of the joint symptoms, which not infrequently occurs after trauma, overuse, or exposure to cold and dampness. The deformity and limitation of motion occur at a later period. In some cases the disease develops without pain; only a gradually increasing stiffness and deformity of the joint take place. When the disease is limited to the hip in elderly subjects it is frequently spoken of as *morbus coxæ senilis.* Occurring in the vertebral column, it is called *spondylitis deformans.*

Treatment.—This should consist in general tonic measures, massage, hydrotherapy, and the hot-air treatment. Potassium iodid, iron, and arsenic seem to be useful in some cases. During the acute exacerbations of pain the joint should be kept at rest on a splint, but motion and massage should be resumed as soon as the symptoms subside. Where marked deformity exists, forcible correction under ether may improve the usefulness of the limb.

Charcot's disease, or *neuropathic arthropathy,* is most frequently associated with locomotor ataxia, but it may occur in connection with other brain and cord lesions. The pathologic changes in the joint are similar to those of arthritis deformans, but the progress of the disease is more rapid and the destruction of tissue generally more apparent than the formation of new bone. As a result the ligaments become relaxed from loss of tissue at the extremities of the bones, and the joint becomes loose and unstable. The disease is, as a rule, monarticular, and in the majority of instances occurs at the knee. It rarely may affect the hip, the shoulder, the elbow, or other large joints.

Symptoms.—A painless swelling of the joint, often accompanied by effusion, with the subsequent development of deformity and instability from relaxation of the ligaments. The ends of the bones may enlarge and exostoses may appear. Spontaneous dislocation is occasionally observed and suppuration has been reported.

Treatment.—The disease is incurable. Splints and braces may be useful to give support to the joint. Excision has been recommended, but the results have been unsatisfactory owing to lack of bony union.

Syphilitic Arthritis.—Joint-inflammation may develop as a lesion of hereditary syphilis, or as a secondary or tertiary symptom of the acquired disease.

Hereditary joint-syphilis is generally an *osteochondritis,* which may give rise to gummatous degeneration, separation of the epiphysis, and secondary involvement of the joint. The acquired disease may be accompanied by a serous synovitis in the secondary stage, or give rise in the tertiary period to a gummatous synovitis or epiphysitis which in its behavior closely resembles tuberculous joint-disease. Arrest of the growth of bone may follow destruction of the epiphysis.

Symptoms.—In the early secondary stage of acquired syphilis the joints may become painful and swollen from the presence of a serous effusion. This, however, quickly disappears under energetic mercurial treatment. In the tertiary period an effusion may also appear, which is generally due to the presence of some neighboring gummatous lesion in the bone or soft parts. Syphilitic epiphysitis or osteochondritis in infants is characterized by enlargement and tenderness of the articular extremity of the bone. If the disease progresses, the joint may be invaded and the condition may closely resemble a tuberculous arthritis. Occasionally it can be distinguished from the tuberculous affection, however, by the absence of muscular rigidity and by the improvement often manifested as a result of antisyphilitic treatment. In the more severe cases rapid destruction of the joint occurs and suppuration may follow, or a painful and useless condition of the joint which has been described as *syphilitic pseudoparalysis.* In acquired syphilis the gummatous arthritis also resembles the tuberculous affection, and differential diagnosis may be impossible. The symptoms which would serve to distinguish a syphilitic from a tuberculous arthritis are: the presence of spontaneous pain during rest at night, the absence of severe pain on motion or manipulation of the joint, the absence of muscular rigidity, and the fact that the tumefaction of the tissues and the synovial effusion if present vary considerably in extent from time to time even without treatment. In most of the reported cases the knee-joint has been the one chiefly involved.

Treatment.—Syphilitic joint-disease should be treated by the exhibition of mercury or of potassium iodide, or of both combined, according to the stage of the disease and character of the lesions. Splints and braces will often be necessary to meet certain indications, as in other varieties of joint-disease. If the joint suppurates, it should be opened and drained. Excision or amputation may be necessary.

Tuberculous Arthritis.—Tuberculosis is the most frequent cause of chronic joint-disease. It is commonest in children, but may occur at any age. Whitman states that of 5461 cases of tuberculous joint disease, seven-eighths occurred in subjects under fourteen years of age. The joints most commonly affected are, in the order of frequency, the spine, hip, knee, ankle, elbow, shoulder, and wrist. Although most authorities admit the possibility of a primary synovial lesion, it is generally conceded that in the majority of instances the disease begins in the epiphysis of an adjacent bone. Nichols, after a careful microscopic examination of the material from more than 120 tuberculous joints, failed to find a single instance in which there was reason to believe that the disease primarily occurred in the synovial membrane. Clarke and others, however, have demonstrated primary synovial tuberculosis in a few adult cases.

The process begins by a deposit of tubercle bacilli in the spongy tissue of the epiphysis of a bone. This produces a minute area of necrosis and softening, surrounding which there is an infected zone of osteitis in which bacilli may be found. Beyond this there is a zone of granulation, which is often excessive and forms a temporary protecting barrier. Occasionally this zone of granulation becomes converted into dense fibrous tissue, and the disease is encapsulated and an apparent spontaneous cure may result. In most cases, however, the area of necrosis and cheesy degeneration gradually extends peripherally, and finally ruptures into the joint, often by a minute opening through the articular cartilage. As soon as tuberculous material gains access to the synovial membrane there occurs an acute miliary tuberculosis of that tissue, an exudate of serum, the formation of cheesy nodules, and a large amount of granulation-tissue, giving rise to a condition which was formerly spoken of as *pulpy degeneration of the joint*. This granulation tissue extends over the articular cartilage, and often beneath it, causing its destruction and often that of the underlying bone. In this way the several articulating bones of a given joint may become involved. As the process advances the cartilages disappear, the bones become exposed and eroded, the extra-articular fibrous tissues become œdematous and softened, the ligaments relaxed, and spontaneous dislocation may occur. If the joint capsule ruptures, the tuberculous material finds its way into the soft tissues, where it slowly extends in the direction of least resistance until it may finally rupture on the surface of the limb.

This lesion of the soft tissues is spoken of as *cold abscess*, and is unaccompanied by pain, tenderness, redness of the skin, or other evidences of inflammation. The fluid contents of a cold abscess consist of necrosed and softened particles of bone and cartilage, fragments of degenerated soft tissues, caseous material, polymorphonuclear leucocytes, and serum. It is called *tuberculous pus*. These cold abscesses may reach a large size and rupture at a considerable distance from the original bone-focus, which may be comparatively small in extent.

Occasionally the tuberculous process may extend beyond the epiphyseal cartilage and infect the diaphysis of the bone.

Symptoms.—Two clinical types of the disease are encountered, one in which the symptoms are primarily in the bone, and the other in the synovial membrane. In the first of these there is stiffness of the muscles moving the joint, with more or less pain and discomfort when the extremity is used. As in the majority of cases the disease occurs in the lower extremity, lameness is generally the first symptom. Following this there are slight swelling and tenderness over the articular extremity of the bone. There is some limitation of motion, and pain is experienced when the joint-surfaces are driven together by a sudden blow. These symptoms develop slowly, and often are referred to as growing pains. When the focus ruptures into the joint, an effusion generally occurs, the joint is fixed in a position of semiflexion by muscular spasm, and as a result of the development of granulation-tissue within the joint and of œdema of the fibrous tissue without a fusiform swelling occurs that is characteristic of the disease (*tumor albus*). At this period the pain and lameness are more pronounced and increase to such an extent as to render use of the extremity impossible. At a later period cold abscesses form, and spontaneous luxation may occur. In the synovial type, which is observed only in adults, the early bone symptoms are absent or overlooked. Swelling of the joint is often the first manifestation of the condition, and is due to a synovial effusion that has developed insidiously without injury and is often unaccompanied by pain. In many instances the swelling is attributed to some unimportant trauma, and the disease may for months or years be regarded as a traumatic synovitis. Sooner or later, however, the disease advances, and as the cartilages and bone become more extensively involved, pain, muscular rigidity, and limitation of motion develop. The frank fluctuation of a serous effusion gives way to the boggy sensation of granulation-tissue, the joint becomes fixed, and the later stages of the disease differ in no respect from those of the more common form of the affection. In both forms, atrophy of the muscles of the extremity, both above and below the lesion, is constantly present, and is out of proportion to the normal atrophy of disuse. The chief distinguishing features of tuberculous arthritis are its slow development, its destructive tendency without coexisting sepsis, and the presence of muscular rigidity, muscular atrophy, and permanent deformity.

Prognosis.—As in all other tuberculous affections, the prognosis depends largely upon the general physical condition of the patient, his hygienic surroundings, and the possibility of the employment of early efficient treatment. The danger to life is largely due to dissemination of the disease to other important organs, to the occurrence of a general miliary tuberculosis or to exhaustion from prolonged suppuration. Bruns estimates the death-rate in tuberculous disease of the joints in the first decade of life to be 36 per cent.; in the second decade, 40 per cent.; in later adult life, 72 per cent. (Whitman). More recent writers, however, place the death-rate considerably below these figures, and it is undoubtedly true that modern methods of treatment have resulted not only in an improvement in the ultimate mortality but also in the functional results.

Under favorable conditions joint tuberculosis is often a self-limited disease. If the surgeon can place the patient in the best hygienic surroundings, remove all undue irritation of the joint tissues, and prevent deformity, time will often bring about a cure by anchylosis.

Treatment.—As in all other conditions of localized tuberculous disease, early and complete removal of the focus constitutes the most successful method of treatment. This, in the early stages of tuberculous arthritis, while the focus is still limited to the bone, is rarely possible, for the reason that the disease is seldom recognized at this period. Rest, fixation by splints, braces, or plaster casts, protection against jars and other sources of trauma, counterirritation, passive hyperæmia by the Bier method, and the avoidance of deformity, constitute the conservative treatment. If these measures fail to arrest the disease, the question of operative treatment should be considered. *Injection* into the joint cavity of an emulsion of *iodoform* in glycerin (10 per cent.) has been advocated by many surgeons, and is a useful procedure in certain cases, chiefly those in which extensive destruction of the bone and cartilage is absent. *Arthrectomy*, or freely opening the joint with removal of the synovial membrane and all necrotic areas and caseous material with the sharp spoon, with subsequent drainage and fixation, is to be recommended, especially in children, in whom excision would be followed by arrested growth of the bone. *Excision* is to be preferred in adults for the reason that the disease can with more certainty be eradicated, and when successful a useful limb is generally obtained. To avoid the danger of general tuberculosis, amyloid degeneration of important organs, and for the relief of chronic invalidism, *amputation* often is indicated in hopelessly diseased and shortened limbs.

The question of opening and draining a cold abscess when the bony focus cannot be successfully reached and removed, is one upon which there is considerable difference of opinion. The fact that such abscesses occasionally undergo spontaneous cure by absorption of the fluid contents and encapsulation and calcification of the caseous detritus, and the fact also that such abscess cavities, when opened, are frequently the seat of a severe and often fatal secondary infection, has led to a good deal of conservatism in their management. Unquestionably a clean incision with subsequent aseptic dressing is better than spontaneous rupture and infection.

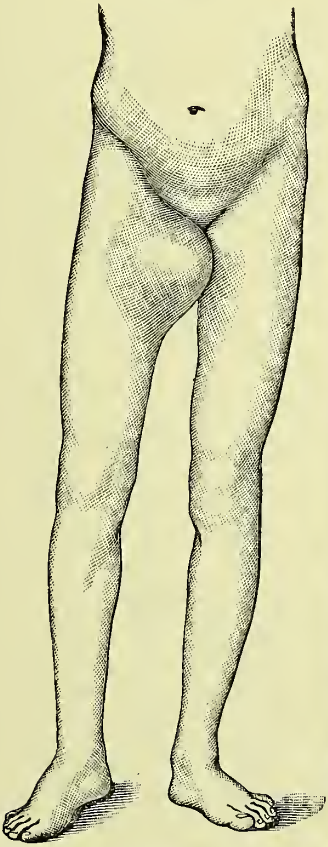
Far more important than the local treatment of the joint is the general treatment of the patient. Most of the victims of tuberculosis joint disease show a progressive deterioration of health and vital resistance, and unless this can be successfully combatted, the chances of local repair are small. Life in the open air both summer and winter, and sleeping out of doors during the greater part of the year is to be recommended. The results of this method of treatment at the Sea Breeze Hospital on Long Island abundantly prove its value. In addition to these measures, the patient should have an abundance of good nourishing food. Iron, cod-liver oil, and general tonics are often useful when specially indicated.

TUBERCULOUS DISEASE OF SPECIAL JOINTS.

Pott's Disease.

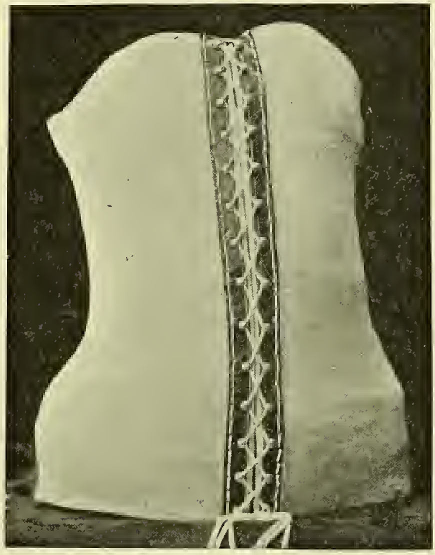
Pott's disease, or tuberculous spondylitis, is a tuberculous disease of the vertebral bodies. It is most common before the twentieth year, 60 per cent. of the cases occurring in the first decade of life. The disease usually begins in the anterior portion of the body of one vertebral segment; it generally ruptures anteriorly, and may extend upward or downward beneath the prevertebral ligament and involve secondarily the bodies of other vertebræ. The intervertebral cartilage may become diseased in the later stages of the process. As the result of a destruction of the vertebral bodies which support the weight of the trunk, an angular curvature of the spine occurs, with the formation of a projecting knuckle of bone behind. Under favorable conditions bony anchylosis and recovery may take place. In other cases a cold abscess forms, which, if the disease is located in the cervical region, may point in the pharynx, *retropharyngeal abscess*, or at the side of the neck; if lower down, in the intercostal spaces near the spine, in the lumbar region, or, by entering the sheath of the psoas muscle, in the groin or thigh, *psoas abscess*. The abscess rarely ruptures into the pleural cavity, lung, or one of the abdominal organs. In many cases the abscess is not recognized during life. Pressure on the spinal cord, causing more or less complete paraplegia, may be due to bony deformity, but is commonly the result of a tuberculous spinal pachymeningitis, or œdema of the meninges and cord. The disease is most common in the dorsal region, the upper lumbar and the lower cervical being next in frequency.

FIG. 295.



Psoas abscess.

FIG. 296.



Plaster jacket.

Symptoms.—Pain is usually an early symptom of Pott's disease.

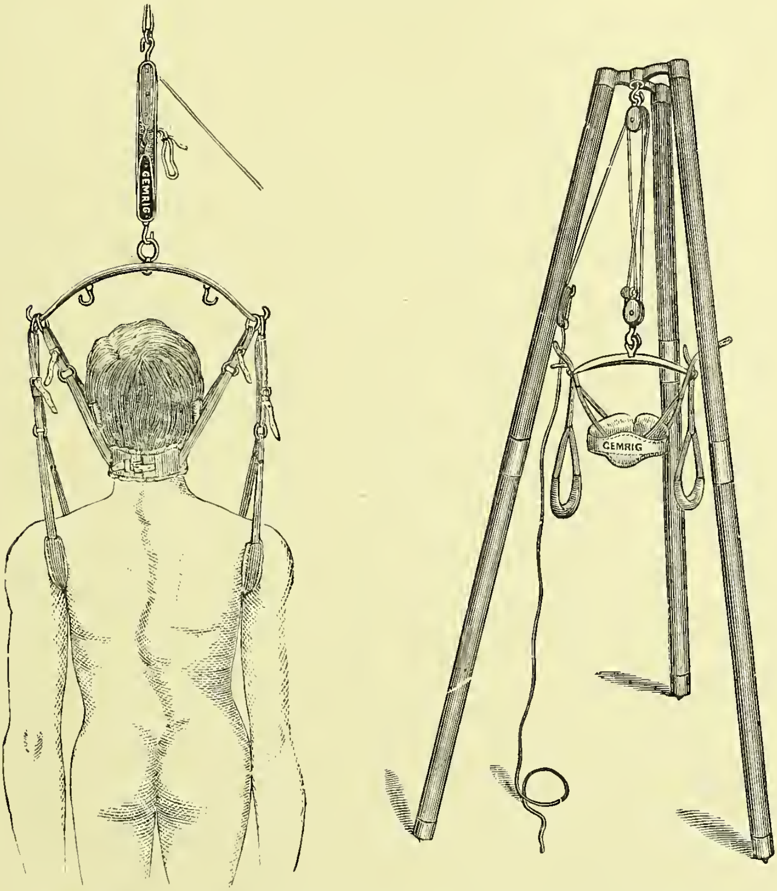
It is increased by jars or sudden movements, and is often paroxysmal at night. It is generally referred to the anterior distribution of the spinal nerves, "stomach ache" being frequently the first manifestation of dorsal disease. The child will assume certain peculiar postures which tend to relieve the pressure on the vertebral column. The walk is often characteristic. The spine is carried rigidly erect, there is generally some lateral curve, but no voluntary motion. The positive signs of the disease are rigidity of the spine due to muscular spasm, and the early occurrence of a prominent knuckle of bone or gibbosity, due to the projection backward of one or more spinous processes from the angular curvature. Fever, abscess, and general physical deterioration, are symptoms which occur after the disease has advanced, especially if the case has not received appropriate treatment. More or less complete paraplegia occurs in from 10 to 20 per cent. of the cases. It is, as a rule, a late manifestation, and occurs most frequently in cases in which the deformity is considerable. In cases where the disease is limited to the lower lumbar vertebræ none of the abovementioned symptoms may be present. Moderate backache or the pointing of an abscess may be the first indication of the spinal lesion. In these cases the pus burrows downward in the pelvis and often emerges through the sacro-sciatic foramen and appears in the gluteal region. In all obscure cases the *x*-rays should be employed to assist in the diagnosis.

Fig. 297.

Bradford's bed-frame. (Bradford and Lovett.)

Treatment.—As in all tuberculous joint-disease, rest, fixation, relief of pressure on the diseased joint, and hygienic measures, including fresh air, sunshine, and an abundance of nourishing food, are the chief measures to be employed. Rest in bed, on an even hard mattress, or, better, on a Bradford frame (Fig. 297), is to be recommended in all cases in which the disease is progressive or is accompanied by much pain and fever. When these symptoms have subsided the ambulatory treatment should be attempted. For this, some apparatus must be worn to hold the spine erect in a position of slight extension, and to remove the weight of the upper part of the trunk from the diseased vertebral body. In the dorsal and lumbar regions these indications are most successfully met by the use of the plaster jacket (Fig. 296) or the Taylor brace.

Fig. 298.

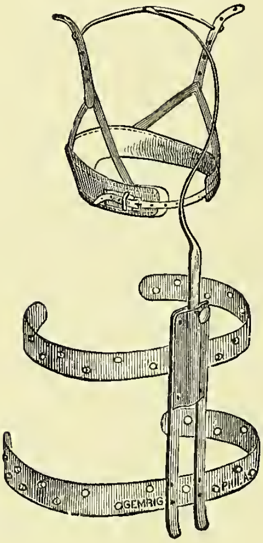


Suspension by means of tripod, for application of jacket in spinal disease.

To apply the plaster jacket the patient should be suspended as shown in Fig. 298. A cotton or woolen undervest is drawn on the trunk and the plaster applied by means of broad roller bandages encircling the trunk from the iliac crests to the highest point to which the plaster can be applied beneath the arms.

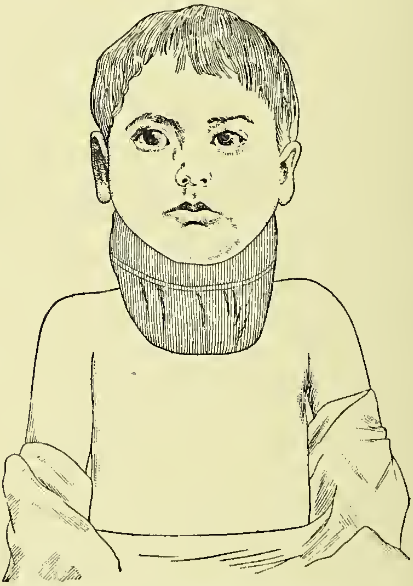
In disease of the upper dorsal or cervical region, the jury-mast attachment shown in Fig. 299 must be added to the jacket to insure upward traction of the head, or the Thomas leather collar may be employed (Fig. 300). Forcible reduction of the deformity under general anæsthesia, as suggested by Calot, or preferably without anæsthesia by an apparatus which causes more or less constant moderate pressure on the gibbosity (Goldthwaite), followed by the application of a plaster jacket, constitutes a method of treatment which has, of late, been extensively employed. It should not be undertaken after bony anchylosis has occurred, or unless rest and fixation for a long period can be carried out. Paraplegia appearing during ambulatory treatment requires recumbency and the administration of potassium iodide. Forcible correction of the deformity will often be followed by rapid improvement in the paralysis. The investigations of Taylor and Lovett show that about four-fifths of the cases of paralysis recover.

Fig. 299.



Head-support and jury-mast.

Fig. 300.



The Thomas collar applied. (Ridlon and Jones.)

When cold abscesses appear, recumbency should be advised. If rupture is imminent, they should be incised and drained, but only with the strictest aseptic care, for a pyogenic infection of a large psoas abscess will, not infrequently, result fatally in a few weeks.

In chronic, long-standing disease of the lowest dorsal and lumbar vertebræ with persistent sinuses, free exposure of the spinal column by means of the König lumbar incision, with removal of sequestra or thorough curettage of a bony focus, will occasionally be followed by a cure (Treves).

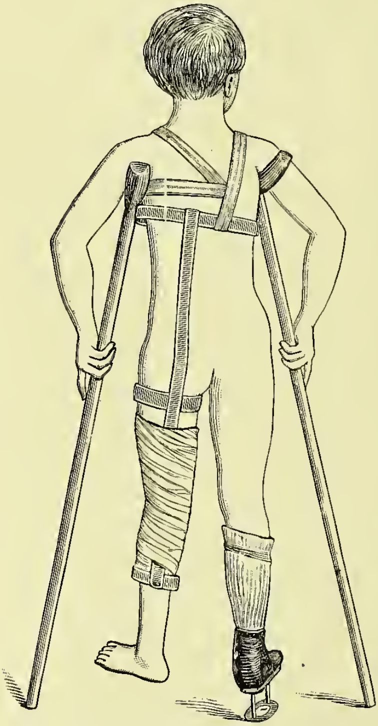
Hip Disease.

Hip disease, morbus coxæ, or *tuberculous arthritis of the hip-joint*, is essentially a disease of childhood and youth. Two hundred and six out of 241 cases reported in Alfer's table occurred before the twentieth year. The disease may begin in the spongy tissue of the head of the bone (upper epiphysis), or in the acetabulum. In either event the synovial membrane is quickly involved, and there is extensive destruction of the articular cartilages and the bone, with relaxation of the ligaments and spontaneous dislocation.

Symptoms.—A slight limp is generally the first symptom, with some pain and stiffness of the joint after an unusual amount of walking. The pain is often insignificant and may be referred to the region of the knee. Sudden paroxysmal pains and "night cries" are frequent as the disease advances. When an effusion occurs in the joint the limb is slightly flexed, abducted, and rotated outward. There are slight fulness in the upper part of Scarpa's triangle, and a partial obliteration of the gluteal fold. Tenderness exists about the hip, and forcing the head of the bone against the acetabulum by striking the trochanter or knee is painful. There is noticeable limitation of motion with well-marked muscular rigidity. This is occasionally spoken of as the stage of *apparent lengthening*. As the disease progresses there is considerable deformity, due to flexion of the limb and tilting of the pelvis. Walking becomes more and more painful and the patient finally becomes bed-ridden. Atrophy of the muscles of the thigh and leg is always present at this stage of the disease, and abscesses may appear. Together with these local symptoms there are afternoon fever, loss of flesh and strength, and general bodily weakness. When the head of the bone is destroyed or the rim of the acetabulum has broken down, upward traction by the muscles results in luxation of the head or neck of the bone, and the formation of an abscess in the soft tissues. The position of the limb is then changed to one of flexion, adduction, and internal rotation. Bony anchylosis and recovery may take place at any period of the disease, but extension of the disease to other organs, and general ill health from prolonged suppuration and suffering, are apt to bring about a fatal termination.

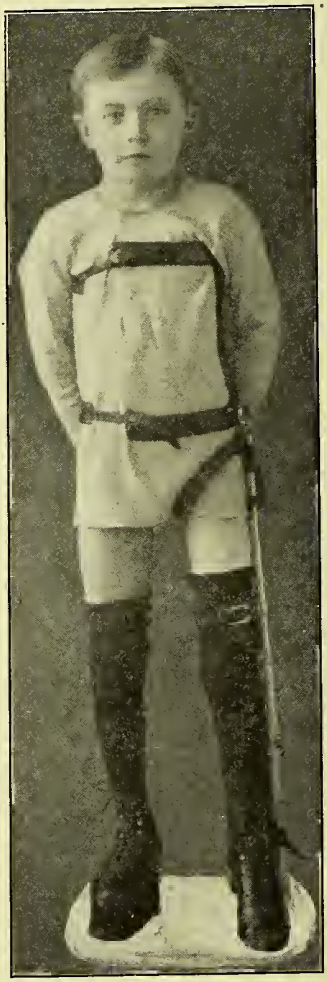
Treatment.—In the early stage of hip disease, before the epiphyseal focus has ruptured into the joint, arthrotomy and removal of the bone focus with the sharp spoon have been followed by complete recovery. Rest in bed with traction on the extremity by means of a weight with pulley overcomes the pain, muscular spasm, and deformity. When this is accomplished the ambulatory treatment, with fixation by means of the Thomas splint (Fig. 301) or the plaster spica, the use of a high-soled shoe on the sound foot, and crutches, is to be

FIG. 301.



Thomas splint applied with patten and crutches.

FIG. 302.



Whitman's splint.

recommended. The favorable effect of traction by the Taylor or Sayre traction splint, which allows walking without crutches, is recognized by most surgeons. Whitman has devised a splint which insures both fixation and traction (Fig. 302). For a description of these splints and the method of their application, the reader is referred to standard works on orthopedic surgery.

If conservative treatment fails to arrest the disease, or if life is threatened by persistent suppuration, excision or amputation is to be recommended.

Excision of the Hip.—The patient is anæsthetized and placed on the sound side. An incision is made from a point two inches above the tip of the great trochanter to two or three inches below, parallel with the shaft. The tissues are divided down to the periosteum and well retracted, the joint-capsule opened, and the head of the bone dislocated. The diseased portion is then removed with the saw or bone-forceps, the acetabular disease removed with a Volkmann spoon, the joint-cavity thoroughly swabbed with pure carbolic acid or a solution of formalin, and the wound partly closed and packed with gauze.

Amputation at the hip-joint is indicated in hopelessly diseased limbs. The final results of hip disease vary greatly, depending upon the opportunities for early efficient treatment. The death-rate reported by Sayre in 212 private cases was only a little over 2 per cent. The hospital death-rate is from 12 to 30 per cent. The functional result of the cured cases depends largely upon the amount of care which is exercised in the treatment.

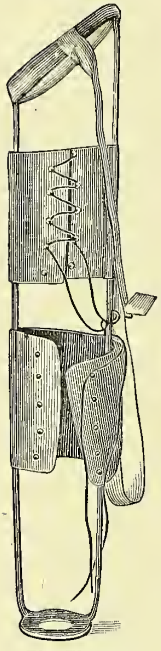
Tuberculous Arthritis of the Knee.

Although knee-joint tuberculosis is more common in childhood, yet a fair proportion of the cases (more than one-third) develop in individuals over twenty years of age. The disease may begin in any of the bones which enter into the formation of the joint, or possibly in the synovial membrane. Epiphysitis of the tibia is, however, the most frequent primary focus, and disease of the femur next.

Symptoms.—In this, as in hip disease, early lameness, stiffness, and pain in the joint constitute the first symptoms. Night cries are less frequent, but tenderness is more marked. There are usually tenderness and thickening of the articular extremity of the tibia or femur. An early synovial effusion may be the first symptom, but this does not necessarily argue in favor of a primary synovial focus, for it occurs in painless epiphyseal foci of disease, before the joint is infected. When the joint is finally invaded, there is the gradual development of a boggy fusiform swelling, with muscular rigidity, fixation of the limb in a partly flexed position, and atrophy of the muscles of the thigh and leg. The lameness becomes more marked, flexion increases, and general deterioration of the health ensues. As the disease advances the ligaments become softened and relaxed, and a spontaneous backward subluxation with rotation occurs, which, with the oval fusiform swelling, gives to the leg a characteristic appearance. Abscess-formation is less frequent than in hip-disease.

Treatment.—In the early stages of the disease it may be possible to locate and remove the bone focus before it has broken through the cartilage and infected the joint. Where the joint is involved the treatment should be conservative. Rest in bed with traction by means of a weight and pulley will relieve pain, correct deformity, and overcome muscular spasm. When this is accomplished the joint should be fixed with a plaster-of-Paris cast extending from the groin to the ankle, or by a Thomas knee-splint (Fig. 303). A high-soled shoe should be provided for the sound foot and the diseased knee protected by the use of crutches; or if the upright bars of the Thomas splint extend below the foot and are joined by a metal plate, the patient may discard the crutches and walk upon the splint.

FIG. 303.



The Thomas knee-splint.

If the disease advances or if abscesses form and rupture, operative treatment is indicated—*arthrotomy* in children, *excision* in adults.

Arthrotomy.—Under general anæsthesia an incision should be made across from one condyle to the other in front of the joint below the patella. The joint should be freely opened and flexed, the diseased synovial membrane curetted, any diseased areas in the cartilages and bone thoroughly scraped out by the sharp spoon, and the entire interior of the joint disinfected with pure carbolic acid or a solution of formalin. If there is a mixed infection with marked sepsis, the cavity should be packed and the leg held in the flexed position (Mayo); in other cases the limb should be straightened, the wound partly united with generous gauze drainage, and the leg placed on a posterior splint. Recovery with bony anchylosis is the best result to be expected.

Excision of the Knee.—The joint is exposed in the manner just described, the leg acutely flexed on the thigh, and the patella and all exposed portions of the synovial membrane removed. The crucial ligaments are next divided, and the articular ends of the femur and tibia sawn off at such an angle as to insure three or four degrees of flexion when the leg is straightened and the cut surfaces of bone brought snugly together. The bones are held in place by two heavy catgut sutures passed through holes made with a drill. The soft parts are united with small rubber tissue drains in each angle, and the leg dressed and held in position by a posterior splint or plaster cast. If there is no infection, the limb need not be dressed for six weeks, when solid bony union should be present. As in other cases of progressive tuberculous joint-disease, *amputation* may be necessary as a life-saving measure.

The prognosis in tumor albus of the knee is less serious than in tuberculous disease of the spine or hip. Excellent functional results are often obtained by early painstaking conservative treatment. The result of excision in adult cases is generally satisfactory. The death-rate is low.

Tuberculous Arthritis of the Ankle.

Tuberculous arthritis of the ankle is a comparatively rare affection. Two-thirds of the cases occur in individuals under twenty years of age. The disease attacks the astragalus primarily in the majority of instances, but it may occur in either malleolus.

Symptoms.—The disease not infrequently follows a sprain. There are stiffness and pain about the joint, with limitation of motion and the formation of boggy swellings in front of and behind the malleoli. The patient limps, and in walking the foot may be rotated outward. There are well-marked muscular rigidity and some atrophy of the muscles of the calf.

If the disease is limited to the subastragaloid joint, there is pain on lateral movement of the os calcis; plantar and dorsal flexion may be perfect (Whitman).

Treatment.—The foot should be encased in a plaster cast, which prevents all motion in the joint and keeps it at a right angle with the axis of the leg. Crutches should be used and general hygienic measures employed.

Operative treatment should be delayed as long as there is any hope of recovery by conservative measures, as the results of excision or arthrectomy are, as a rule, unsatisfactory. Whitman strongly advises *removal of the astragalus* when this is found to be the seat of the primary focus. To accomplish this, the joint should be freely opened from the outside by a curved incision beneath the external malleolus, and extending well forward over the joint. The peronei tendons are divided and the joint-surfaces separated. After removal of the bone the foot is replaced, the tendons sutured, and the external wound partly closed with generous gauze packing.

Tuberculous Disease of the other Tarsal Bones.

Tuberculous disease of the other tarsal bones is occasionally encountered. Of these, the calcaneum and euboid are the ones most frequently affected. The treatment differs in no respect from that of other tuberculous joints.

Tuberculous Arthritis of the Shoulder.

Tuberculous arthritis of the shoulder is a rare affection. The disease may begin in the head of the humerus or in the glenoid cavity.

The earliest **symptoms** are pain, stiffness, muscular spasm, and swelling. The pain may be referred to a point near the insertion of the deltoid muscle. A tender point is generally found just below the tip of the acromion. Fever and general failure of health occur late. Muscular atrophy may be well marked, especially of the deltoid. The bone is generally enlarged, and the entire region of the joint appears broadened. Abscesses may occur and point near the anterior border of the deltoid muscle.

The **treatment** should be the same as in other tuberculous joint-affections: rest, fixation, and the avoidance of jars and other traumata. The use of the sling and chest-binder (Fig. 44) will often give relief, or the plaster spica of the shoulder and arm may be employed.

Excision of the shoulder may be required if the disease is progressive. A longitudinal anterior incision should be made either through the deltoid muscle or between it and the pectoralis major. The joint should be opened and the head of the bone resected by the subperiosteal method, if that is possible. This saves the attachment of the muscles and renders more probable future use of the arm. After the diseased tissues are thoroughly removed the wound should be closed in part only, ample room being left for drainage. In the majority of instances in which recovery follows a fairly useful limb results.

Tuberculous Arthritis of the Elbow.

Tuberculous arthritis of the elbow is more frequent than disease of the shoulder or wrist. It is common in early adult life. The primary infection may be in the olecranon or the external condyle of the humerus.

The **symptoms** are pain, stiffness, and limitation of motion in the joint. Inability to extend the forearm completely is often the earliest sign of the disease. The joint later becomes enlarged, the swelling at first appearing on either side of the olecranon and tendon of the triceps and obliterating the normal depressions in these localities. As the disease advances the joint becomes fixed, usually in a position midway between flexion at a right angle and full extension. The swelling increases and produces a fusiform boggy tumor. Suppuration may occur, sinuses form, and the entire articulation becomes a pulpy granulating mass.

The conservative **treatment** of this joint should not be too long attempted, as the results are not satisfactory. If fixation and general hygienic measures do not promptly arrest the progress of the disease, excision is indicated.

Excision of the elbow may be accomplished in the following manner: Under general anæsthesia a longitudinal incision is made over the back of the joint, the centre of which will lie over the olecranon. When all the tissues are divided down to the bone and well retracted, the periosteum of the olecranon and upper part of the ulna should be incised together with those of the humerus, and the soft parts separated from the bones on either side until the condyles are freely exposed, care being taken to avoid injury to the ulnar nerve. The arm is then acutely flexed and the articular surfaces of both bones exposed in the wound. These are removed entire or the diseased portions scraped away together with all infected synovial membrane. The wound is then partly united, packed with gauze, and dressed at a right angle in the hope that bony anchylosis will result.

Tuberculous Arthritis of the Wrist.

Tuberculous arthritis of the wrist is rare in childhood, and comparatively infrequent at any age. Any one or all of the joints may be affected.

The **symptoms** are pain, stiffness, swelling, and limitation of motion, with muscular atrophy and general ill-health. The swelling is more marked on the dorsal aspect of the wrist, and may be fusiform in shape. Fluctuation may be detected at an early period, but is soon replaced by a boggy induration.

The **treatment** should consist in rest on a splint and compression, as pressure here seems to give a large measure of relief (Bradford and Lovett).

Excision of one or more of the bones of the wrist is indicated in advanced disease.

The best incision to expose the lesion is a longitudinal one over the back of the wrist, between the extensor tendons of the thumb and those of the index finger. These tendons are separated with retractors, and the long and short extensors of the wrist brought into view and retracted. The attachment of the short extensor to the third metacarpal bone is next divided, and the carpal bones well exposed by wide retraction of the tissues. Only the bones that are diseased should be removed. The use of glutol or formalin gelatin powder here and in other tuberculous cavities has been found by the author to bring about healthy granulation and often complete healing in what seemed to be hopeless cases. After closure of the wound with drainage, the arm should be placed on a palmar splint and kept at rest for several weeks.

As in tuberculous disease of the lower extremity, amputation may occasionally be necessary as a life-saving measure in disease of the shoulder, elbow, or wrist.

Sacro-iliac Disease.

Tuberculosis of the sacro-iliac joint is a rare affection. It occurs chiefly in young adults.

The **symptoms** in the beginning are obscure, and often resemble those of lumbar Pott's disease. There is pain on standing or walking, and on pressing the iliac crests together; the patient limps, and instinctively rests his weight upon the healthy leg. On walking the spine has a lateral deviation, and the motion of the legs is chiefly below the knees. This gives a shuffling characteristic gait. A cold abscess may form and point in the gluteal region or burrow deep in the pelvis.

Treatment.—Rest in bed, with extension during the acute stage. Later, a pelvic binder and crutches. Abscess in the pelvis may be reached by a posterior incision with resection of a portion of the ilium (Van Hook).

FLOATING CARTILAGE.

Free cartilaginous masses are occasionally encountered in the larger joints, especially the knee. They represent either small fragments broken off from the articular surfaces by traumata, or, more commonly, chondrified portions of the synovial folds or fringes which have become detached by the movements of the articulation.

Symptoms.—When these movable bodies are caught between the articular surfaces of the bones, they give rise to a sudden acute pain, with "locking of the joint." The patient often falls to the ground and is unable to move the limb. Forcible flexion and extension will often cause the symptoms to disappear. Careful palpation will generally reveal the presence of the cartilage.

The **treatment** should consist in aseptic incision and removal of the foreign body. The joint, however, should never be opened for this purpose unless the cartilage is distinctly felt and held by the fingers of the surgeon, for extensive exploration of the joint-cavity is often unsuccessful and accompanied by grave risk of infection.

Dislocation and injury to the semilunar cartilage of the knee-joint may produce similar symptoms, and is described on p. 805.

Anchylosis.

The loss of motion in a joint is spoken of as anchylosis. This may be due to trauma resulting in fracture and bony deformity; to inflammation, giving rise to fibrous adhesions, loss of cartilage, and bony union of the joint surfaces; to exostoses; to muscular contractures; or to the formation of peri-articular adhesion or cicatrices.

The prophylatic treatment by massage, passive motion, hydrotheraphy, electricity, etc., has already been mentioned in the sections devoted to the varous injuries and joint lesions giving rise to anchylosis. After anchylosis has once occurred, however, the problem is a far more difficult one.

When the anchylosis is due to muscular contractures or scar tissue, much can be accomplished by tenotomy and plastic operations; when due to vicious union of fractures involving the joint surfaces, open operation and readjustment of the fragments will sometimes bring about a restoration of function. In the early stage of fibrous anchylosis, forcible rupture of the adhesions under general anæsthesia, followed by persistent passive motion will occasionally be successful, but the pain is often severe, and a gradual return to the former condition frequently is observed. In chronic non-tuberculous arthritis where there is a marked tendency to bone formation, forced movements not infrequently accentuate the pathologic progress and do positive harm.

A large number of experiments have been made with a view to restoring motion in these hopelessly anchylosed joints by means of open operation, separation of the joint surfaces, removal of the synovial membrane and implanting various substances, as ivory, celluloid or silver plates, rubber tissue, or animal membrane between the articulating bones. Some brilliant successes have been obtained by Murphy and others in the use of layers of aponeurosis, fatty tissue and muscle.[1] Buchmann[2] has recently reported two cases where he successfully transplanted an unopened first metatarso-phalangeal joint to the elbow region after excision of the anchylosed elbow-joint. In both instances the wounds healed and painless voluntary motion was obtained, in one case through an arc of 30 and in the other through an arc of 70 degrees.

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[1] *Jour. of Amer. Med. Assoc.*, May 20, 1905.

[2] *Zentralblatt für Chirurgie*, No. 19, 1908.

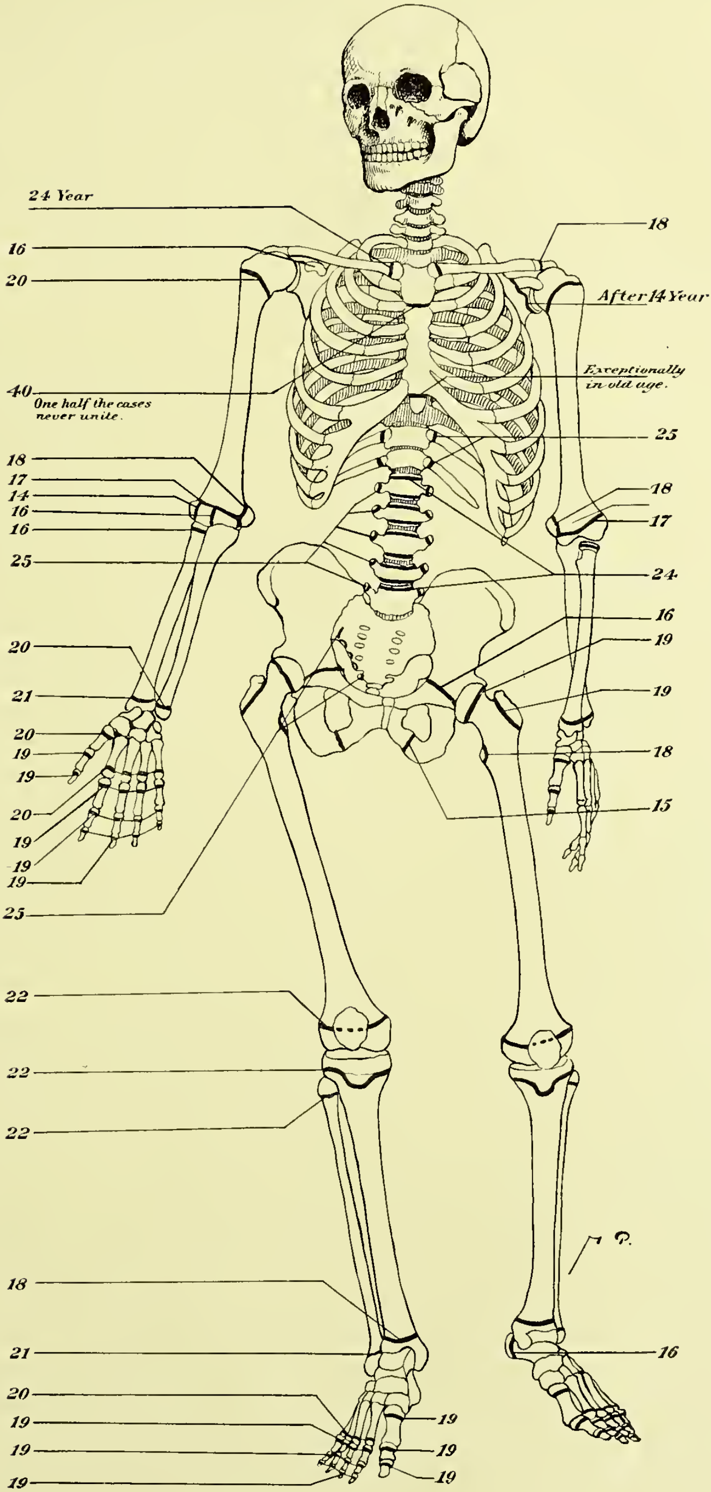
Further experiments along these lines will, it is hoped, furnish data upon which to base final conclusions.

Arthrodesis.

In certain cases of paralysis, or in other instances where an excessive and uncontrolled mobility of a joint is present, the usefulness of the limb may be increased by obtaining firm bony anchylosis. To the procedure which produces such anchylosis, the term arthrodesis is applied.

The method usually adopted is to expose the articular surfaces by a suitable incision, and then to remove by knife, curet, or saw the greater part of the articular cartilages, after which the wound is closed and the limb retained in the most favorable position by a plaster cast. The operation is most frequently indicated in cases of infantile paralysis of the lower extremity, where nerve or tendon grafting is for any reason impracticable.

PLATE XIV



Time of Bony Union of the Various Epiphyseal Junctions.

CHAPTER XXVII.

FRACTURES.

THE term *fracture*, in its surgical sense, signifies a break or violent separation into two or more fragments of a bone or cartilage.

A *simple* fracture is one which is covered by unbroken soft tissues. A *compound* fracture is one in which the bone-lesion is exposed by a wound of the overlying parts. A *comminuted* fracture is one in which the bone or cartilage is broken into a number of small fragments. The terms *transverse, oblique, longitudinal, spiral,* T- *or* V-*shaped,* are commonly used to indicate the general direction of the line or lines of separation.

A fracture is said to be *impacted* when one fragment is forcibly driven into another and remains more or less fixed in that position. The terms *single, double, multiple, recent, old, united* and *ununited* are frequently used in describing fractures, the significance of which will be readily understood.

Injuries of bone or cartilage which do not result in complete separation are sometimes spoken of as *incomplete fractures.* These are subdivided into *fissures* or cracks without displacement of fragments; *green-stick fractures,* where a portion of the shaft of a long bone is fissured, the remaining portion bent—these conditions are not infrequently encountered in children, and are often difficult of recognition; *depressions,* where a portion of a flat bone is driven inward; and *separations at the epiphyseal line* before complete union has been effected, occurring therefore in early life.

Etiology.—The predisposing causes of fracture are, in general, conditions which render the bones more friable, such as the physiologic atrophy of old age, malnutrition from any of the wasting diseases, new growths, osteomyelitis, or the lesions of syphilis or tuberculosis. The exciting causes of fracture are either external violence, muscular action, or a combination of both of these agencies. External violence may be *direct,* where the break occurs at the point of injury; or *indirect,* where it occurs at a distance from the point of application of the injuring force. A depressed fracture of the skull from the blow of a hammer would be an example of a fracture by direct violence; a fracture of the clavicle from a fall on the hand would be an example of one by indirect violence; a fracture of the patella occurring during an attempt to jump would be an example of one by muscular action; a blow on the point of a rigidly flexed elbow, fracturing the olecranon, would furnish an example of a fracture by both direct violence and muscular action.

Repair of Fractures.—The processes of repair in fractured bones are practically the same as in wounds of the soft parts. As the bone breaks there is a considerable laceration of the surrounding muscles and fasciæ, blood is effused, and the periosteum may be stripped from the ends of the bone. If the fracture is quickly reduced and the bony fragments are accurately replaced and securely held in their normal position, the process is very simple. There is, at first, a reactionary hyperæmia followed by an exudation of lymph which solidifies around the broken fragments, and encloses the blood-clot, torn muscle, fascia, and periosteum. This soon becomes vascularized, and is gradually converted into fibrous tissue: it constitutes the provisional callus, and is the hard fusiform mass felt around the broken fragments after the first week. At a later period this mass becomes calcified; the part between the broken fragments remains as the permanent callus; the external or ensheathing callus, as well as the internal, central or medullary callus, is gradually absorbed (Fig. 304).

If the broken fragments are not accurately replaced, if there is overriding, or if there is constantly more or less motion between the fragments, the process is slower, the primary exudate greater, and more or less of the ensheathing callus may remain as a permanent bridge between the fragments (Fig. 305).

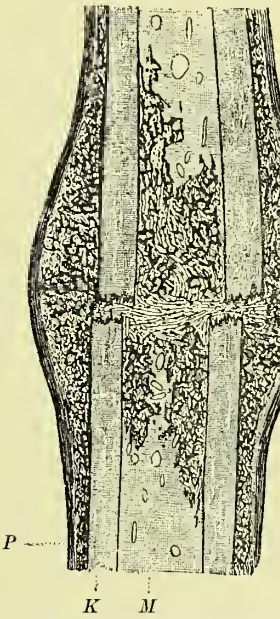
In *compound fractures*, if the wound can be thoroughly cleansed and united, primary union may take place and the process may be the same as in a simple fracture. If, however, the wound is infected or for any other reason cannot be closed, healing takes place by granulation. Necrosis of the denuded ends of the bone is very likely to occur under these conditions, small fragments from time to time becoming detached and appearing among the granulations, indefinitely delaying permanent closure of the wound and repair of the fracture. If the soft parts heal rapidly, the necrosed fragments of bone may become surrounded by the ensheathing callus and absorbed, or later removed by operation.

Diagnosis.—The subjective symptoms of a fracture are pain and impairment of function. The objective signs are deformity, localized tenderness, abnormal mobility, and crepitus. In fractures by direct violence there are often, in addition, swelling, ecchymosis, and abrasions of the overlying soft parts.

Deformity often may be appreciated by inspection alone, by palpation, or by comparative measurements. Not infrequently the deformity is produced only by manipulation.

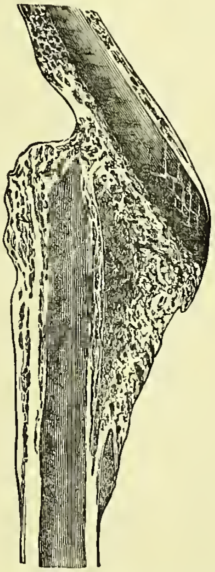
Abnormal mobility may be made evident by the muscular efforts of the patient or by the examination of the surgeon. Crepitus is the feeling imparted to the hand of the examiner by the rubbing together of two or more fragments of bone; occasionally it is heard as well as felt.

Fig. 304.



Fracture three weeks old; periosteal and medullary callus partly ossified, partly cartilaginous: *P*, periosteum; *K*, bone; *M*, medulla. (Tillmanns.)

Fig. 305.



Fracture healed with deformity (callus luxurians). (Tillmanns.)

In the diagnosis of fractures it is important that a methodical examination be made in every suspected case, definitely establishing the presence or absence of all of the above symptoms. The surgeon should proceed in the following manner:

First obtain from the patient or a witness an accurate account of the accident; then a statement of the immediately resulting impairment of function, as the ability to walk after an injury of a leg, use of the arm or hand after injury of that member; the mental condition after a head trauma; the presence or absence of cough or bloody expectoration after a crush of the chest; or the passage of blood from the rectum or bladder after injuries about the pelvis.

The part should then be inspected after a careful removal of the clothing. If a wound of the soft parts be found, suggesting the possibility of the fracture being compound, this at once should be protected by a clean dressing to avoid further contamination during the subsequent examination. In injuries accompanied by marked and characteristic deformity it is often possible to arrive at a positive diagnosis of fracture at once by inspection of the part, and in such case it is preferable not to proceed further with the examination until ready to reduce the fracture and apply the first dressing, as repeated moving and manipulation of fractured limbs, especially if accompanied by severe injury of the soft parts, is unnecessary, extremely painful, and dangerous.

If the diagnosis is not established by inspection, the limb should then be gently palpated and the area of greatest tenderness ascertained. The outline of each bone should next be felt from its upper to its lower extremity, and any deformity or point of special tenderness noted. Abnormal mobility and crepitus should be sought for and the exact point noted. In fractures of the shaft of the femur, by simply placing a hand under the seat of injury and raising the limb, angular deformity, mobility, and crepitus may often be demonstrated. In other instances, especially in fractures near the joints, gentle traction and rotation will often elicit these signs. In fractures of both bones of the leg these signs are easily made evident by the gentlest manipulation. In fractures of the fibula alone, it is more difficult, and they are obtained best by holding the leg firmly by one hand immediately above the injury, the thumb being placed over the point of greatest tenderness; then, by gently inverting and everting the foot with the other, one or more of these signs can usually be elicited. Fractures about the wrist, elbow, or shoulder are generally made out by their characteristic deformity or by careful palpation during flexion, extension, and rotation of the joint with traction on the limb. Deformity and abnormal mobility are generally absent in fractures of the ribs. Crepitus is obtained best by pressure over the ribs during deep inspiration and expiration. It may often be elicited by the use of the stethoscope placed over the point of greatest tenderness, the grating sound being heard during the movements of respiration. Mobility and crepitus in fractures of the pelvis are obtained best by pressing together the crests of the ilia or by direct palpation of the pubic arch, rami, or sacrum by rectal or vaginal examination. In fractures of the skull or spine the above-mentioned positive signs are often wanting; the diagnosis must be made by exploratory operation or the evidences of visceral injury.

The use of the x-rays in the diagnosis of fractured bones has been found of the greatest service, and their employment has become a matter of routine in most hospitals where many fractures are treated. While it may often give an exaggerated picture of deformity in comparatively unimportant variations from the normal, and its constant use may in a measure lead us to ignore and discard other methods, yet the fact must be admitted that by its employment a far more accurate idea of a given injury can be obtained than by any other method, and its use should be generally recommended.

Complications.—In nearly all fractures there is more or less bruising or injury of the soft parts, due to the trauma which produced the bone-lesion. When this is not accompanied by extensive laceration of the skin or muscles, nor by injury to the nerve-trunks or vessels, it is unimportant.

Compound Fractures.—If a wound in the soft parts leads to the seat of fracture, constituting a *compound fracture*, the condition is serious, and should receive the most thorough and prompt attention, for infection in a case of compound fracture gives rise frequently to the most virulent forms of septicæmia. Previous to the introduction of the modern aseptic and antiseptic methods of wound treatment, in the great majority of instances compound fractures of the extremities were rapidly fatal or the patient recovered only after amputation; and while the modern methods of dealing with such conditions have to a great extent removed these dangers, and by appropriate treatment the majority of such cases may be saved, it should not be forgotten that in compound fracture of any of the larger bones we have a condition which may result fatally, and one in which this result can be avoided only by the most thorough antiseptic treatment.

Ischæmic Paralysis.—This rare but important complication of fracture is a pressure paralysis, caused by the temporary absence from the tissues of oxygenated blood, and often results in complete and permanent loss of function of an extremity. The lesion was first described by Volkmann in 1880. Since that time about 60 cases have been reported in the literature. It is probable that the lesion is far more common than is generally supposed, but that it is not generally recognized, or the symptoms attributed to other causative factors. In the great majority of cases the lesion occurs in children and in the upper extremity.

Tight bandaging, the application of a plaster-of-Paris circular cast or of snugly applied wooden splints immediately after an injury may cause progressively increasing pressure on the soft tissues as the reactionary swelling occurs. This gives rise to an acute ischæmia of the parts, which, if unrelieved for six or more hours, produces marked degenerative changes in the muscles and nerves, resulting in paralysis, contractures, sensory, and trophic disturbances. Other factors are sometimes present, as large hæmatomata, thrombosis of the vessels, and direct nerve injury, but the essential feature is an absence of blood supply to the muscles.

The *symptoms* of this condition are pain, coldness, œdema, and cyanosis of the distal portion of the extremity, with the possible formation of blebs. If unrelieved, paralysis quickly follows, associated with a marked shortening of the flexor muscles, resulting in acute flexion of the fingers which cannot be overcome by the application of any reasonable amount of force. Numbness and sometimes complete sensory anæsthesia are present, with thin glossy skin and atrophic nails. In the severest cases gangrene of the extremity may occur. At a later period the anæsthesia and trophic disturbances may disappear, but the contraction of the muscles, which is due to connective-tissue change, is permanent. The features which serve to distinguish this condition from other forms of paralysis are the simultaneous occurrence of the paralysis and contractions, and the inability to extend the fingers without flexion of the wrist.

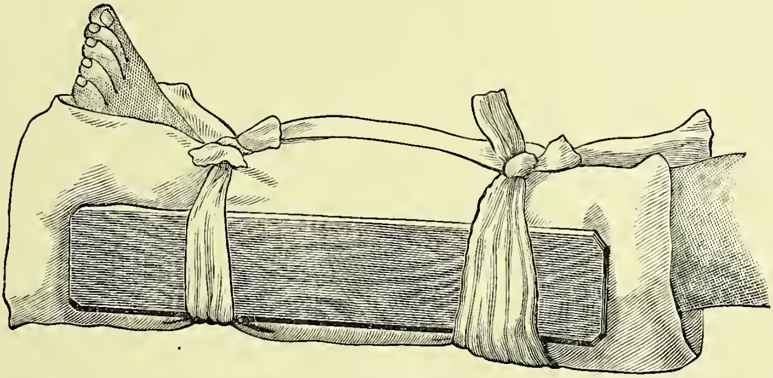
The *prognosis* in ischæmic paralysis is generally unfavorable. Unless the condition can be relieved before six hours have elapsed, permanent damage results to the muscles.

The *treatmemt* should consist in prompt removal of splints and tight bandages as soon as the condition is recognized. Fixation of the fractured bones should be disregarded for a time, and massage, passive motion, hot and cold baths, electricity, and Bier's hyperæmic treatment applied to restore the circulation and improve the nutrition of the muscles. At a later period if the anæsthesia and trophic disturbances persist, the nerves should be exposed, freed from their fibrous beds, and transplanted to the subcutaneous tissue or surrounded by Cargile membrane. Lengthening the flexor tendons or, better still, shortening the arm by a resection of from 2 to 4 cm. of the radius and ulna, often will overcome deformity and enable the shortened but not wholly degenerated flexor muscles to functionate.

Fat-embolism is a plugging of the pulmonary capillaries with free fat-globules. The fat-globules are derived from the marrow, and are supposed to gain entrance to the blood current through the venous sinuses in the broken bone. They are first arrested in the capillaries and smallest arterioles of the lungs, but are occasionally found in the brain, kidneys, and other viscera. The symptoms are those of an exaggerated shock, with rapid, labored respiration, and cyanosis. There also may be restlessness, delirium, and coma. The condition often is rapidly fatal, and is occasionally mistaken for pneumonia or delirium tremens.

Delirium tremens seems to follow fractures more frequently than other injuries of the same character, due possibly to the fact that the fracture frequently follows a state of intoxication, and the sudden withdrawal of the alcohol after the injury gives rise to the symptoms. It is advisable under such circumstances to give a certain amount of alcohol, preferably ale, during the first few days after such an injury, and to combat the early restlessness and insomnia by generous doses of sodium bromide, digitalis, and chloral.

Fig. 306.



Pillow splint.

Injuries of the veins may result in extensive extravasation of blood, forming *hœmatomata*, and these by pressure may cause œdema or even gangrene.

Occasionally arterial wounds give rise to *traumatic aneurisms.*

Injury to the main arterial trunk of a limb may cause a rapidly advancing *gangrene* requiring amputation.

The late complications of fracture are *stiffness of the joints* from intra-articular adhesions, misplaced bony fragments, or exuberant callus; *paralysis* from laceration of a nerve-trunk or from pressure of callus; *muscular weakness* from atrophy or adhesions between tendons and their sheaths; *delayed union* or *non-union,* which may be due simply to ill-health or deficient blood-supply, but is generally caused by faulty position of the fragments or the interposition of a layer of muscle or fascia between the broken ends of the bone; *pseudarthrosis,* when after non-union the ends of the bones become rounded and a kind of joint-cavity is formed secreting serous fluid; and *vicious union,* a union of the fragments with deformity, giving rise to impairment of function.

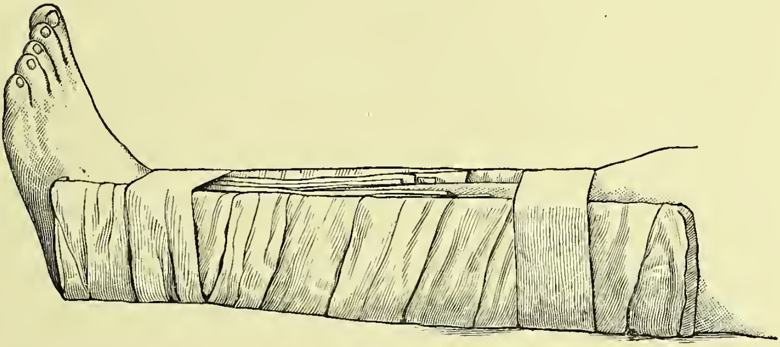
Treatment of Fractures in General.—In fractures of the lower extremity, skull, spine, or pelvis, or in the presence of other fractures complicated by shock or severe and painful contusions, the patient should be transferred to his home or a hospital on a stretcher. In removing him to and from the stretcher, the injured part should be carefully guarded by the surgeon or protected by an improvised splint, to prevent further injury of the soft parts. Fig. 306 illustrates an improvised pillow splint for fracture of the lower leg. If there is a wound of the soft parts and a probability of the fracture being compound, the wounded area should be immediately protected by an antiseptic pad, and later the entire limb shaved, scrubbed, and otherwise prepared as for a surgical operation.

In *simple fractures*, after the diagnosis has been established by the methods mentioned above, the next step is *reduction* of the fracture, or, as it is usually spoken of by the laity, "setting the bone." This may be easily accomplished in superficially located bones, where there is little or no swelling or muscular rigidity, by gentle traction and manipulation, the reduction being evidenced by disappearance of the deformity and a return to the normal of the outline of the limb. In many instances, however, accurate replacement is difficult, owing to swelling, great pain, muscular rigidity, and the difficulty of determining with precision the position of the fragments. In these and in all doubtful fractures, especially about the joints, general anæsthesia should be used and the reduction accomplished under the guidance of the x-rays.

The *retention* of the fragments in their normal positions after reduction, while often easy, will occasionally tax the ingenuity of the surgeon to the utmost. When the fractured bone is held in position by strong layers of muscle and fascia passing from a near and uninjured parallel bone, as in the case of fracture of a single rib or the fibula, practically no retention apparatus is required, the treatment being directed toward keeping the parts at rest. On the other hand, in fractures of the shaft of the femur, humerus, clavicle, or of both bones of the forearm, even if once completely reduced, the bones are not infrequently misplaced by muscular action on the broken fragments after application of the splints.

In troublesome cases of this kind the x-ray furnishes us the most valuable aid, for by the constant use of the fluoroscope during the manipulations necessary to reduction and the application of the splints or other retention apparatus, every step of the operation can be controlled. Recently the writer was able to treat successfully in this manner an exceedingly obstinate case of fracture of both bones of the leg in which slipping of the fragments and marked displacement of the bones occurred no less than six times during the application of the plaster cast. Each time the deformity was recognized and corrected by use of the fluoroscope, although there was never any apparent deformity or change in outline observed in the soft parts.

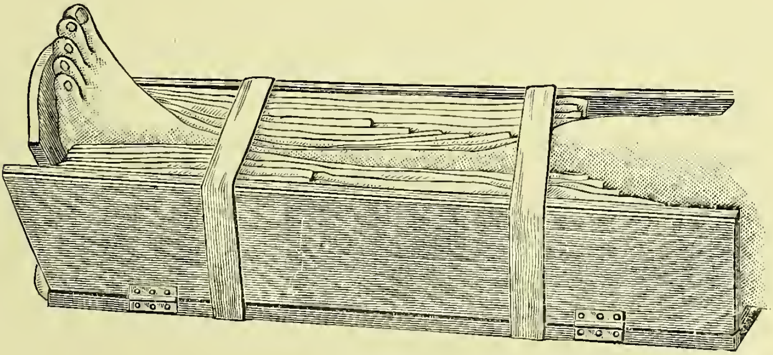
Fig. 307.



Side splints.

Almost any stiff material may be used for splints; thin strips of wood well padded may be placed on either side of a broken arm or leg and held in position by adhesive strips and bandages (Fig. (307); sheets of heavy pasteboard or gutta-percha may be softened in hot water and moulded directly to the injured part and secured by bandages; or strips of crinoline thoroughly impregnated with plaster-of-Paris cream may be employed in the same manner. The latter has the advantage of hardening quickly while the in-

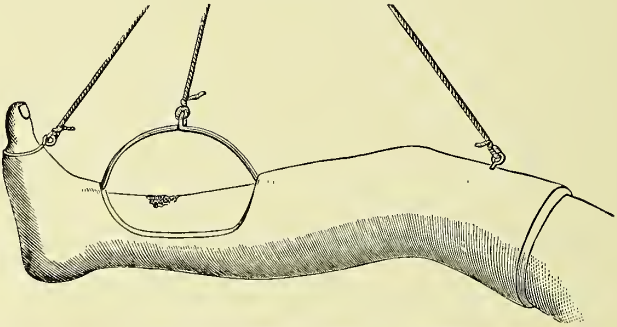
Fig. 308.



Fracture-box.

jured member is being held in position. In applying any splint or retention device the soft parts should be protected, especially over the seat of injury and in the neighborhood of bony prominences, by cotton pads. Care should be taken to avoid undue pressure, and a portion of the limb below the seat of injury should always be exposed, to enable the surgeon to watch the condition of the circulation. In all cases in which extensive contusions, œdema, or ecchymoses exist, the dressings should be removed and the parts inspected frequently until all danger of strangulation, sloughing, or gangrene has passed. In fractures of the lower leg accompanied by great swelling, severe bruising, ecchymosis, and the formation of blebs on the skin, the fracture-box (Fig. 308) should be used, for it not only gives great relief to the patient by allowing the application of wet dressings, such as a solution of aluminium acetate or lead-and-opium wash, but it also enables the surgeon to inspect and treat every part of the injured leg without change of position or danger of disturbing the fragments.

Fig. 309.



Fenestrated plaster dressing. (Stimson.)

If there is little or no swelling, in simple fractures of the leg or forearm, a cast of plaster-of-Paris, dextrin, or starch, can often be immediately applied. This is particularly desirable if the patient exhibits the premonitory symptoms of delirium tremens.

To apply an encircling plaster cast to a member, the fracture should be properly reduced and the limb held firmly in position by an assistant. A thin layer of cotton or lint should first be evenly applied to the part. This is accomplished best by the use of rollers made from sheet wadding, an exceedingly soft and delicate material which may be obtained in any dry-goods shop.

After the limb is evenly covered by this material several rollers of crinoline impregnated with plaster-of-Paris should be placed in warm water to which a teaspoonful of salt has been added. The plaster rollers should then be applied to the limb, covering all parts evenly with from four to six or eight layers of the plaster-holding material. Where a light cast is desirable, thin strips of splint wood may be inserted between the layers, and less plaster applied. If the fracture is compound, or if there exists a wound of the soft parts requiring a dressing, a window should be left or subsequently cut in the cast, freely exposing the wounded area, which may then be dressed without removing the supporting cast (Fig. 309).

In fracture of the long bones where there is a marked tendency to shortening of the limb and overriding of the fragments by the action of strong muscles, this should be overcome by the use of some form of extension apparatus. It not infrequently happens in fractures of bones surrounded by soft tissues, and in comminuted fractures, particularly in the neighborhood of important joints, that accurate replacement by manipulation is impossible. In these cases open operation is to be advised, freely exposing the injured bone, followed by accurate adjustment of the fragments, and retention by suture, wiring, the application of metal plates or medullary dowels (Figs. 310, 311, 312, and 313). These operations, however, should only be undertaken by experienced surgeons, and under conditions of strict asepsis, as infection following such procedures often results in extensive osteomyelitis, leading to amputation of the limb or death of the patient.

Compound Fractures.—While deformity and loss of function are the common results of unskilful treatment in simple fractures, prolonged illness, loss of a limb, or death from sepsis, may be the outcome of unskilful treatment in compound fractures. In addition to the indications present in the treatment of simple fractures, we must, in the case of compound fractures, seek to prevent or overcome septic infection of the wound. In fractures by indirect violence, when there is little injury to the soft parts, and the opening leading to the bone is small, due to the projection outward of a small splinter of bone, careful cleansing of the surrounding skin and the application of a sterile dressing are recommended by most surgeons, in the hope that infection has not taken place, and that the injury may thereby be quickly converted into a simple fracture. In the writer's opinion, however, the safest rule to follow is to explore and drain all compound fractures if the surroundings are such as to enable the surgeon to conduct a clean operation. This should be done under general anæsthesia; the limb should be shaved, scrubbed, and otherwise prepared as for a strictly aseptic operation. The wound should then be sufficiently enlarged to allow thorough inspection of the line of fracture; all detached fragments of bone, clots, lacerated strips of muscle and fascia, should next be removed and the cavity thoroughly irrigated with a solution of mercuric chloride (1 : 1000). A 1 : 50 solution of formalin or hydrogen peroxide is often of value in wounds which are already inflamed and foul, the latter serving also to arrest troublesome oozing of blood. The wound can then be partly closed, thorough drainage being provided by gauze packing or rubber tubes, a sterile dressing and a suitable retaining apparatus applied. When there is a tendency to separation of the fragments they can be held together by a suture of chromicized catgut. The fenestrated plaster cast or wire splint, allowing free access to the wound and drainage-openings, will be found useful if there is reason to believe that the wound is badly infected and will require an early change of dressing. In cases in which the wound is small and in which little or no infection is suspected, a circular plaster cast may be applied, and the dressings allowed to remain in place for several weeks.

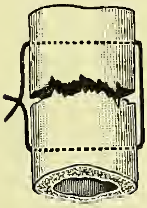
In cases in which the infection spreads widely and is not controlled by the ordinary methods, wider incisions and freer drainage may sometimes be successful. Under these conditions the continuous warm bath has often proved useful, the solution used being mercuric chloride (1 : 100,000) or carbolic acid (1 : 1000). Amputation should be promptly resorted to in cases in which an acute osteomyelitis develops, and in which the life of the patient is in danger from general sepsis.

Delayed union or *non-union* generally is the result of faulty position or the interposition of a layer of muscle or other soft tissue between the fragments. In these cases open operation, freshening the ends of the bone and correct apposition, maintained, if necessary, by sutures, nails, medullary dowels, bone-pegs or metal plates, is the treatment to be followed (Figs. 310, 311, 312, and 313). It occasionally happens that the reparative powers of the individual are so reduced that callous formation does not take place even if the position of the bones is correct. Massage, with moderate irritation of the fragments by friction, will often excite an inflammatory reaction and stimulate repair. Bier and Schmieden, believing that callous formation bears a direct relation to the amount of extravasated blood, advise the injection between and about the fragments of from 30 to 40 c.c. of fresh venous blood drawn from the patient's arm. This to be repeated at intervals of ten days or two weeks.

Visceral injuries, caused by fragments of bone penetrating the cranial, thoracic, or abdominal cavities, lacerating or causing pressure on the contained organs, call for immediate surgical relief.

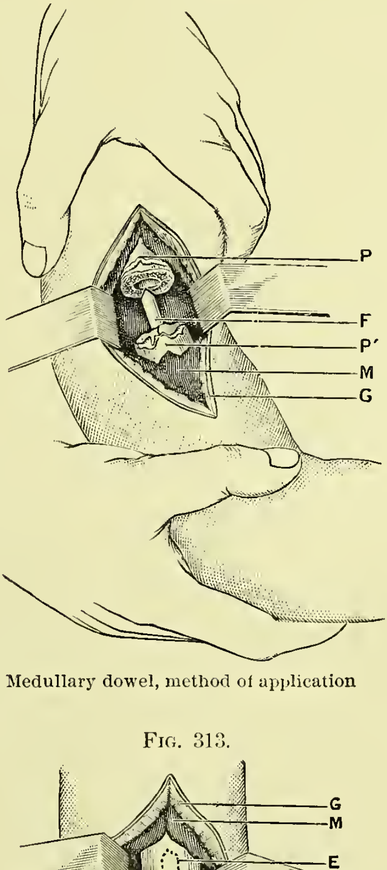
Massage is often of the greatest value in developing an increase in the circulation of the injured part, and thereby preventing marked atrophy of the muscles and causing rapid absorption of the inflammatory exudates. Its use also favors nature's processes

FIG. 310.



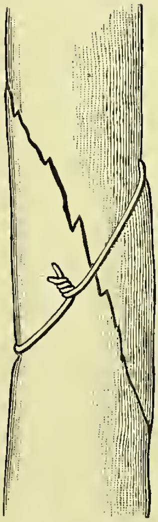
Bone suture.

FIG. 312.



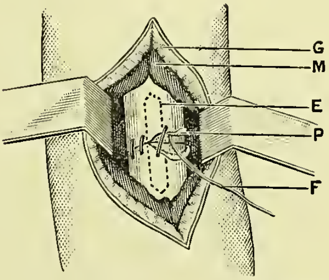
Medullary dowel, method of application

FIG. 311.



Wire band.

FIG. 313.



Medullary dowel, bone fragments in place.

of repair and prevents stiffness of the joints and tendons. It may be employed as soon as the limb can be handled without displacing the fragments, and should be applied regularly three or four times a week in fractures near joints where extensive exudation exists in and about the tendon-sheaths.

The general health of the individual should also receive attention, and phosphate of calcium or the syrup of hypophosphites should be given if union is apparently delayed from lowered vitality.

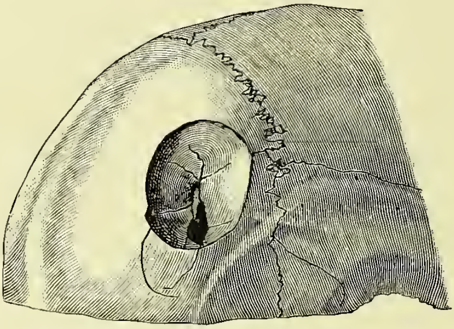
In the aged it must be remembered that long continuance of the recumbent position favors hypostatic congestion and pneumonia, and an effort should be made to employ apparatus which will allow the patient to assume a sitting posture as soon as possible. This is especially important if there is a chronic bronchitis or emphysema present.

Fractures of the Skull.

The best classification is that suggested by Stimson:

Circumscribed fractures of the vault, caused by a blow from some comparatively small missile, and producing a limited fracture at the point of contact, usually compound, and often accompanied by extensive splintering and depression of the inner table (Fig. 314).

FIG. 314.



Circumscribed depressed fracture of the skull. (König.)

Fissured fractures with generalized brain injury, in which the fracture is caused by some violence which compresses and changes the shape of the skull, producing fissures either parallel with the direction of the force or transverse to it. These fissures generally involve the base of the skull, may extend from the vault to the base, are often very extensive, may be single or multiple, and are usually accompanied by injury of the brain or its envelopes, which may be independent of the line of fracture.

Not infrequently fractures are found to possess characteristics of both of these varieties.

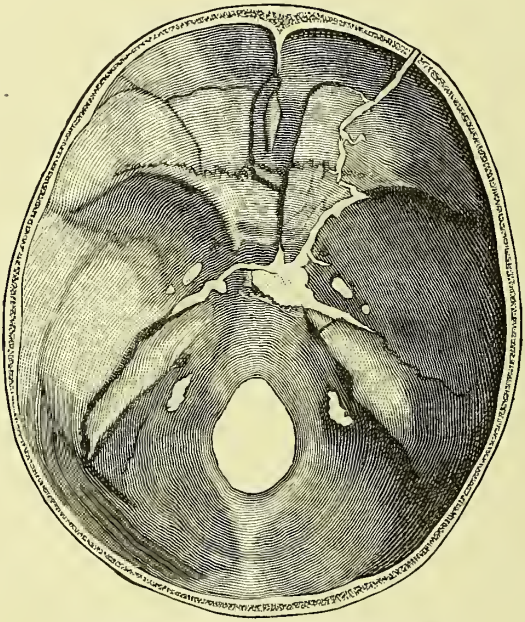
In the first of these classes the fractures are generally produced by blows, as from a hammer, a falling rock or iron bar, or by striking the head violently against some small object in falling. In these cases there may be little or (rarely) no fracture of the outer table, with extensive splintering and depression of the inner table of the bone, due to the greater brittleness of the thin inner plate, and also to the fact that in such injuries the concave inner surface of the bone is temporarily rendered convex by being overbent, and breaks as a stick which is being bent over the knee, first on the surface opposite to the point of pressure. In young children these injuries may result simply in a depression of the skull without fracture, which may later become obliterated. In the second class the injury may be produced by blows from some heavy object upon any part of the head, by falls striking the vertex, occiput, parietal or frontal regions, by falls upon the feet causing a fracture of the base by force imparted through the spinal column, by blows upon the jaw, the force being conducted through the condyles to the bone, or by any crushing injury which compresses the skull (Fig. 315).

Both of these varieties may be compound, the former at the seat of injury, the latter at the point of injury or by a complicating scalp wound, exposing a fissure at a distance from the injury, or more commonly by a fissure at the base opening into the nasal fossa, the vault of the pharynx, or the auditory canal. Occasionally fractures of the anterior fossa of the base extending into the orbit may become compound by a tear in the conjunctiva.

The complications which may occur in fractures of the skull are far more important than the bone injury itself. These are either immediate or remote. The immediate complications are contusions or lacerations of the membranes or of the brain-substance; hemorrhage, either extradural, between the dura and the cortex, or into the brain itself; injury to the cranial nerves as they emerge from the base of the skull; and infection, which may result as a circumscribed or diffuse meningitis or encephalitis. The latter complications are generally fatal, or if recovered from frequently occasion adhesions, cicatrices, or cysts, giving rise to epilepsy, persistent headache, and various other disturbances of the nervous system.

The **prognosis** depends entirely upon the injury to the brain and its coverings, for a simple fracture of the skull without injury to the brain would no more endanger a person's life than a simple fracture of the clavicle or radius; and even compound fractures of the convexity, if unaccompanied by cerebral injury, recover under appropriate treatment almost without exception. Whether fracture at the base, communicating with the nasal, aural, or pharyngeal cavities, where appropriate antiseptic treatment cannot be carried out, would offer a grave prognosis if unaccompanied by brain injury, cannot be determined, as such a condition is practically never found. In general, therefore, the prognosis will depend upon the surgeon's estimation of the cerebral injury. In the first class, circumscribed fractures of the vault, the prognosis is, as a rule, favorable; while in the second class, fissured fractures with generalized brain injury, the prognosis is extremely grave.

Fig. 315.



Fracture of the base of the skull. (Bruns.)

Symptoms.—A moderate degree of shock is generally present in injuries resulting in fracture of the skull. This is evidenced by pallor, giddiness, nausea, sometimes vomiting and loss of consciousness, and has often entirely disappeared before the arrival of the surgeon. In the localized fractures of the convexity a depression with contusion, hemorrhage, or wound of the scalp, together with the history of injury, may lead at once to a correct diagnosis. In the severer cases involving the base the symptoms depend largely upon the amount of cerebral injury. Where this is comparatively slight there may be no impairment of brain function. In other cases there may be stupor and cerebral irritability; in the severest cases the only symptom is coma, with a history of head injury. The coma is apt to be profound and accompanied by some rise in temperature. The pupils may be irregular, and there is often bleeding from the nose, mouth, or ear.

In fractures involving the anterior fossa of the base there are generally nasal hemorrhage and subconjunctival ecchymosis; in those involving the middle fossa, pharyngeal hemorrhage and a discharge of blood and cerebrospinal fluid from one or both ears. In fractures of the posterior fossa there may be no characteristic symptoms, or there may be hemorrhage into the pharynx or a slowly developing ecchymosis over the mastoid due to blood finding its way to the subcutaneous tissues along the emissary veins of the mastoid process.

Cranial nerve palsies are frequently present and help to confirm the diagnosis; but occasionally the mental condition of the patient is such as to preclude the possibility of obtaining such data. Of the cranial nerve palsies, that of the seventh is the one most frequently noted; the others commonly observed being the third, fourth, sixth, and eighth. Facial paralysis, deafness, and paralysis of one or more of the ocular muscles following head injury, without other symptoms, are therefore strongly suggestive of a fracture of the base.

Treatment.—All compound fractures of the vault should be explored; and if depression exists, the depressed bone should be raised or removed. The wound should be rendered surgically clean, and drainage provided for by means of gauze or a small strip of rubber tissue, the scalp wound partly closed, and an aseptic dressing applied. If there is a wound of the dura or of the cortex, the dura should be incised, any foreign matter, clot, or contused fragments of tissue removed, and the wounded area thoroughly exposed and cleansed with hydrogen peroxide and sterile salt solution. If the laceration is extensive, the wound should be left open and generously packed with sterile gauze; if the wound is comparatively trivial, the dura should be united in part and the subdural space drained with a small strip of rubber tissue.

In simple fractures of the vault with moderate depression and without symptoms of brain pressure or injury, the treatment should be rest in bed and an ice-cap to the head; if marked depression, comminution, or mobility of the fragments exists, or if there is evidence of brain pressure or injury, the fracture should be exposed by an incision of the scalp, the fragments removed or readjusted, and the wound closed with a small drain.

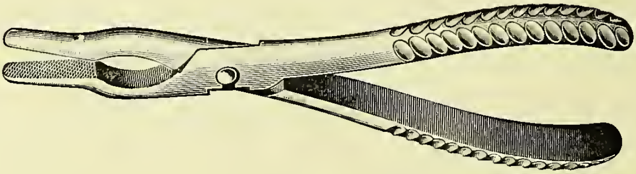
In fractures involving the base with generalized brain injury, the treatment should consist of absolute rest in bed in a darkened room, an ice-cap to the head, light diet, free catharsis, and nerve sedatives. Special nurses or some restraining apparatus will be necessary in most cases on account of the violent delirium which often follows such injuries. Frequent irrigation of the ear, nasal and nasopharyngeal cavities with some antiseptic fluid is indicated when there is evidence of a rupture of the mucous membrane in these regions. The ear may also be packed with sterile cotton. Packing the nasal or nasopharyngeal cavities is contraindicated, as it favors rather than prevents infection by retention of the always infected secretions.

Fractures of the Nasal Bones.

Fractures of the nasal bones are usually due to direct violence. The fragments are generally displaced laterally or are driven inward. The line of fracture may extend to the superior maxilla or lachrymal bones, and involve the tear-duct.

The **symptoms** are deformity, swelling, and ecchymosis of the overlying soft parts, and bleeding from the nose. Mobility and crepitus may be obtained by palpation ; obstruction to nasal respiration is occasionally present from deflection of the cartilaginous septum or swelling of the mucous membrane. Efforts to blow the nose may result in extensive swelling of the surrounding parts and emphysema.

FIG. 316.



Adams forceps.

The **treatment** should consist in early replacement of the fragments, as the tendency to rapid union is marked. If considerable deformity exists, an anæsthetic should be administered and the fragments moulded into place by the fingers alone or by the fingers aided by some blunt instrument introduced within the nostril.

Displacements of the septum can be corrected by use of the

Adams forceps (Fig. 316). Retention of the fragments in their normal position is usually accomplished by small pads of gauze placed on either side of the nose and held in place by strips of adhesive plaster. Gutta-percha plates moulded to the nose are often of service to protect against further injury. Packing the nose may be necessary to arrest hemorrhage, but is rarely necessary to support the fragments.

Fractures of the Malar Bone and Zygoma.

Fractures of the malar bone and zygoma are rare, generally due to direct violence, and are often accompanied by fracture of the superior maxilla. They are recognized by the deformity, localized tenderness, mobility, and crepitus. In fractures of the zygoma the bone is usually displaced, and there are pain and difficulty in opening and closing the mouth, owing to the traction of the masseter muscle and the contact of the depressed fragment of bone with the coronoid process or temporal muscle.

Replacement under these conditions may be difficult, and accomplished only by an external incision and drawing the fragment forward with a hook. Depressed fractures of the malar bone are occasionally reduced by incision and introducing a metal screw, by which the depressed fragment can be raised, or by opening the antrum from within the mouth and pressing the bone into place. Under ordinary conditions, however, these procedures are unnecessary, as a sufficiently accurate replacement can be effected by manipulation.

Fractures of the Superior Maxilla.

Fractures of the superior maxilla are practically always the result of direct violence. The processes are more often involved than the body of the bone; the fracture may involve the antrum, and is generally associated with other injuries.

The **symptoms** are pain on motion, bleeding from the mouth or nose, bruising and ecchymosis of cheek and lips, abnormal mobility, and crepitus. Emphysema may follow an attempt to blow the nose.

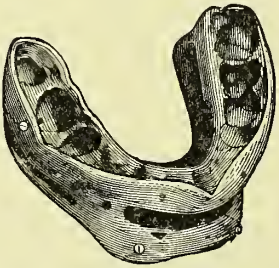
Treatment.—The broken fragments should be replaced and held in position by wiring the teeth, by an interdental splint, or by direct suture with chromicized catgut or silver wire. If there is a tendency to displacement of the fragments, the jaw should be kept closed by a four-tailed bandage (Fig. 63) and liquid food only administered through a tube. When the mucous membrane of the mouth is torn in these and in fractures of the lower jaw, infection is always present, giving rise to a foul, purulent discharge and an extremely offensive odor to the breath. To minimize the discomfort arising from this, the mouth should be frequently cleansed with hydrogen peroxide and other astringent and antiseptic solutions.

Fracture of the Lower Jaw.

Fractures of the lower jaw are comparatively common in males of middle age, generally due to blows or falls; the commonest location of the break is at or near the canine tooth. Two or more fractures may occur. Fractures limited to the alveolar process or of the condyloid or coronoid processes are rare. These fractures, when involving the horizontal ramus, are probably always compound, communicating with the oral cavity.

Symptoms.—In single fracture of the horizontal ramus the deformity is slight, easily appreciated, and readily reduced. In fracture involving the coronoid process the upper fragment is drawn upward by the temporal muscle. In fractures of the condyloid process there are pain on moving the jaw, a lateral deviation of the chin toward the affected side, and displacement of the condyle upward and forward by traction of the external pterygoid. In double fracture, on either side of the symphysis, the intervening fragment is drawn backward by the action of the hyoid muscles. The horizontal ramus is so easily palpated through the mouth that diagnosis in fractures of this part of the bone presents no difficulties. In fractures above the angle the diagnosis must be made from the characteristic deformity and finding a point of localized tenderness, abnormal mobility, and crepitus.

FIG. 317.



Gunning's interdental splint, with opening for introducing food.

The **treatment** of a single transverse fracture through the horizontal ramus is comparatively simple. In many cases all that is necessary is to keep the part at rest after reduction of the deformity. This is accomplished best by making an interdental splint of gutta-percha (Fig. 317), and keeping the jaws closed upon it by means of a four-tailed bandage. If there is a marked tendency to displacement of the fragments owing to obliquity of the line of fracture or the presence of two or more fractures, the fragments can often be firmly held by wiring the teeth together on either side of the break, or, better, by direct union of the fragments with silver wire or chromicized catgut.

As in fractures of the upper jaw, especial care should be taken to keep the mouth disinfected. Not infrequently a localized osteomyelitis follows fracture of the jaws, requiring subsequent operation.

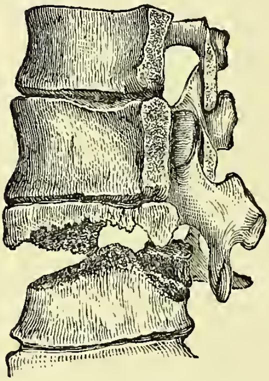
Fractures of the Spine.

Fracture of the spine is so often accompanied by a dislocation that the two forms of injury had best be considered together. Injuries of this kind generally result from a fall or some severe crushing force which violently bends the vertebral column. Parts of one or more of the vertebræ may be fractured by a direct blow, as the spinous process or vertebral arches, and occasionally muscular action may play a minor part in the injury. Pure dislocations are rare, five-sixths of the cases occurring in the cervical region. Fractures are more commonly met with in the cervical and dorsal regions, the most frequent point of injury being the fifth and sixth cervical, the last dorsal, and first lumbar. The line of fracture, when the body is involved, may be in any direction, but is generally transverse or oblique (Fig. 318). Comminution may occur, and occasionally impaction takes place, giving rise to angular deformity without displacement. In by far the greater number of these injuries there are both fracture and dislocation, a condition which has been termed *fracture-dislocation.* While fracture of a portion of a vertebra may occur without producing any injury of the cord, in the great majority of cases these injuries result in a temporary or permanent displacement which gives rise to a more or less serious cord lesion (Fig. 319). It occasionally happens that the immediate displacement which has produced a permanent transverse lesion of the cord has been spontaneously reduced before the patient is seen by the surgeon.

The cord-lesion may be simply a *contusion* from the driving inward of a fragment of a fractured arch, *compression* from displaced bone, or hemorrhage which may be extradual, in the subdural space, or in the anterior horn of the gray matter of the cord (hæmatomyelia); or the cord may be *crushed* and its functions permanently impaired by the deformity which follows the severe forms of this injury.

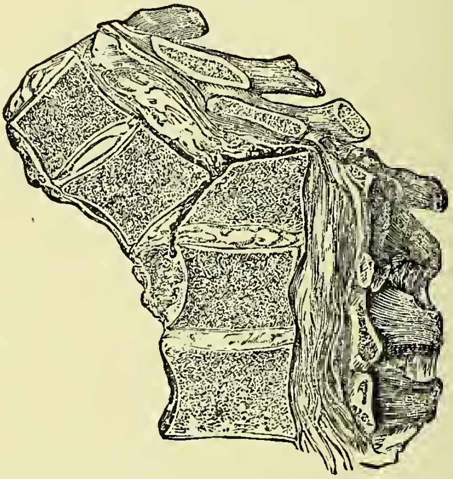
The **symptoms** of fracture of the spine are of two kinds: those due to the injury to the spinal column, and those due to the injury of the cord. The former are deformity, localized tenderness, pain on movement of the trunk, and crepitus; the latter are sensory and motor paralyses, retention of urine, involuntary movements of the bowels, priapism, the formation of bedsores, variation in the reflexes, and occasionally hyperpyrexia.

FIG. 318.



Transverse fracture of vertebra. (Stimson.)

FIG. 319.



Displacement of the vertebræ causing compression of the spinal cord.

In fracture without dislocation there may be no deformity present; generally, however, there is a prominence of one or more of the spinous processes, which may amount to a well-recognized angular deformity. In fracture of the spinous process there may be a depression over the injured process. Localized pain and tenderness are practically always present, but crepitus is frequently absent.

Fracture or dislocation of the *atlas* and *axis* is very rare, and is almost always fatal either immediately or after a few days. The symptoms of fracture or dislocation of the upper four or five cervical vertebræ are more or less complete paralysis of motion and sensation below the injury, rigidity of the neck, localized pain, embarrassment of the respiration, priapism, and hyperpyrexia. There may be no recognizable deformity.

Fracture or dislocation of the *lower cervical* and *upper dorsal* presents noticeable deformity; the paraplegia is generally complete to the region of the diaphragm, irregular above this point. Paralysis of the upper extremity may develop immediately or after several hours or days. There is absence of thoracic respiration, and paralytic myosis may be present. It is generally rapidly fatal if the phrenics are involved; more slowly if below that point.

Fracture-dislocations of the dorsal and lumbar region are less rapidly fatal, and when below the eleventh dorsal the paralysis may be incomplete owing to the rarity of marked displacement in this region, and consequently less complete injury to the cord, and also to the fact that below the second lumbar vertebra the canal contains only the cauda equina, a bundle of nerve-trunks. Partial or complete recovery from the paralysis may take place after these fractures.

Not infrequently after injuries to the spinal column there is complete paraplegia, with paralysis of the bladder and rectum and the rapid formation of bedsores, thermo-anæsthesia, but without loss of tactile sensation. In these cases the lesion is not a crushing injury of the cord, but a hemorrhage into the anterior horns of the gray matter (hæmatomyelia). If no other lesion exists, recovery from this condition may be confidently expected in from six to twelve weeks.

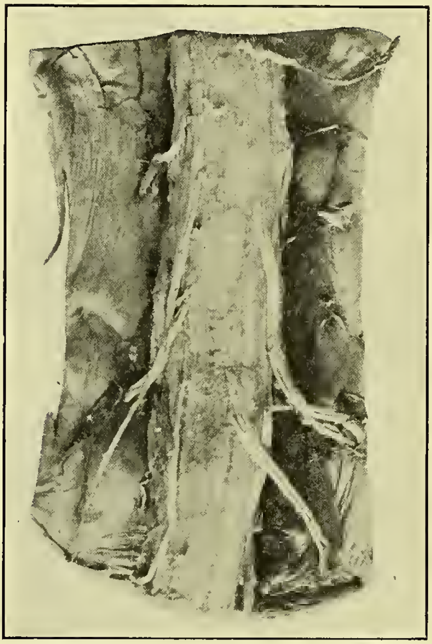
Treatment.—In the treatment of fracture or dislocation of the spine the surgeon should be guided by the probable condition of the cord. In all cases in which there is reason to believe that the injury to the cord is not a crushing one, attempts should be made to reduce the displacement if any exists, and to bring about a union of the fracture by fixation. This is sometimes effected in the cervical region by extension and counter-extension, aided by manipulation at the seat of injury, and should be followed, if successful, by the application of a plaster collar and head bandage. In fractures of the dorsal and lumbar regions reduction is often aided by suspension. In the majority of instances, however, reduction of a fracture-dislocation can only be accomplished by open operation. In all cases, whether reduction is accomplished or not, fixation by a plaster jacket gives comfort to the patient and favors union.

The question of operative intervention in injuries of this kind is one upon which there is considerable difference of opinion.

In crushing injuries of the cord restoration of function never occurs, so that relief of pressure by operation could be of no possible value. On the other hand, hæmatomyelia, in which the prognosis is favorable, recovers as well without as with operation. This leaves only the cases in which the symptoms are due to pressure from depressed bone or hemorrhage, upon which operation offers any chance for improvement.

In these cases laminectomy may reveal the cause of the pressure, which can sometimes be removed. It should be remembered, however, that hemorrhage may exist with a crushing injury of the cord, which upon inspection through an opening in the dura shows no macroscopic sign of injury. Fig. 320 represents such a condition, in which the writer believed that complete recovery would

FIG. 320.



Intradural hemorrhage due to fracture-dislocation which had spontaneously reduced.

probably follow removal of the clot, whereas upon microscopic examination the cord was found to be wholly disintegrated by a crushing injury.

Fractures of the Sternum.

Fractures of the sternum are comparatively rare. They occur mostly in middle-aged males, from direct violence or severe crushing injuries, and are generally accompanied by fractures of the ribs. The line of fracture is usually transverse, and its commonest seat is at the junction of the manubrium with the body of the bone, opposite the second intercostal space. As union of these two portions of the bone is often delayed until old age, this injury is often a separation of the two portions rather than a fracture. Fractures immediately above or below this point are more common than fracture at the lower part of the bone. Separations of the ensiform are occasionally encountered.

In fracture or separation at the junction of the manubrium with the body of the bone the lower fragment generally lies above and sometimes overrides the upper.

Longitudinal fractures have been observed. Compound and comminuted fractures are exceedingly rare except in connection with gunshot wounds. In severe crushing traumata hemorrhage into the mediastinum and lesions of the thoracic viscera may complicate the injury.

The **diagnosis** of this condition is comparatively easy in the absence of marked swelling of the overlying soft parts, the signs being irregularity in the outline of the bone, localized tenderness, abnormal mobility, and crepitus. Spontaneous reduction frequently occurs. In these cases the only treatment necessary is the application of a firm binder, adhesive strips, or a plaster jacket. When there is little or no tendency to displacement and no pain simple rest in bed is all that is required.

If marked deformity exists from overriding of the fragments, reduction may offer difficulties. It is generally accomplished by bending the body backward and exerting pressure over the projecting fragment while the patient takes a deep breath. If this does not succeed, reduction can generally be effected by an open operation under anæsthesia, and replacement of the fragments by an elevator or hook, or by screwing a gimlet into the depressed fragment and drawing it into place.

Fractures of the Ribs and Costal Cartilages.

Fractures of the ribs and costal cartilages are of frequent occurrence. They are caused by direct violence, as a blow or fall upon the thorax; by indirect violence, as in a crushing injury; by muscular action, as in coughing or sneezing. The middle ribs are more frequently fractured than those nearer the upper and lower boundaries of the thorax. The injury may be limited to a single rib, or many may be involved in the trauma. Under ordinary conditions the point of fracture is more often near the middle of the bone, and anterior to this point rather than posterior. Fracture near the bony and cartilaginous junction is not uncommon, and fracture of the costal cartilage is occasionally observed.

When a single rib is fractured, there is, as a rule, no displacement, as the muscular and fascial layers serve to hold it in place. When, however, several ribs are broken, these attachments are often torn, and there may be displacement with overriding. When the trauma is severe, the fragments may penetrate the pleura or lung, giving rise to pneumothorax, collapse of the lung, hæmoptysis, and subcutaneous emphysema. In injuries of this character the pericardium and heart may also be wounded. Hæmothorax from a wound of an intercostal artery may occur.

The **diagnosis** of fracture of a rib is generally to be inferred if, after a blow or fall upon the chest, there is a point of localized tenderness, with acute pain on inspiration, coughing, or sneezing. Crepitus may often be elicited by palpation or heard with the stethoscope. When several ribs are fractured, abnormal mobility and crepitus are easily obtained by palpating the region with the flat hand. Fractures of the ribs are rarely compound, except those produced by gunshot or other penetrating injuries.

The **prognosis** depends upon the visceral trauma. In a simple fracture of one or more ribs without involvement of the pleura recovery is rapid and uneventful. If the lung or other important structures are involved, the prognosis is necessarily more grave, depending upon the extent and character of the visceral involvement.

The **treatment** consists in rest, limitation of the movements of the chest-wall, and measures addressed to the pleural and pericardial complications if these are present. It is rarely necessary to reduce a fracture of a rib, as there is seldom marked displacement. If, however, a fragment is driven inward and remains a source of irritation to the pleura or lung, it should be properly reduced. When this is not easily accomplished by manipulation and inspiratory efforts of the patient, replacement by a hook or elevator through an open wound may be necessary.

Limitation of the thoracic movements will often promptly relieve the pain. This is accomplished best by a snugly fitting binder or by the application of adhesive plaster straps, always during expiration.

Fractures of the Pelvis.

Fractures of the pelvis may occur from crushing injuries, from falls from a height upon the iliac crest, trochanter, sacrum, pubic symphysis, or feet; or from blows received in this region from some heavy object. These fractures are often accompanied by injury to the bloodvessels or some of the pelvic or abdominal viscera.

These fractures may be conveniently divided into two groups: those which involve the integrity of the pelvic brim, and those which are limited to a part remote from the true pelvis. The former are far more serious in their results than the latter. In fractures of the pelvic ring the commonest seat is through the pubic rami, both horizontal and descending rami being often involved, as these are the weakest parts of the bony pelvis. Occasionally the fracture is bilateral, the symphysis being entirely separated and driven backward into the pelvic cavity. Vertical fractures of the ilium extending into the true pelvis often accompany fractures of the pubic arch. The acetabulum may be fissured by a fall upon the feet or trochanter, its rim broken, or the head of the femur may be driven through its walls into the pelvis. Horizontal and vertical fractures of the sacrum occur in connection with other fractures of the pelvis, and a separation of the sacro-iliac joint may be produced under similar conditions. All of these fractures involving the pelvic brim are likely to be associated with visceral injury. Those most frequently found are wounds of the urethra, rupture of the bladder, tears of the rectum, injuries to the iliac vessels, and lacerations of the intrapelvic portion of the ureter.

Fractures of the iliac crest, coccyx, or other parts not involving the integrity of the pelvic brim, occur, but are not generally associated with injury of the viscera or vessels.

The **diagnosis** is usually easy. There is a history of severe injury, followed by pain in the region of the pelvis, which is increased by any movement of the trunk or legs. Pressure over the iliac crests toward the median line will always elicit pain unless the fracture is limited to the coccyx, descending rami, or tuberosity of the ischium. Careful palpation of the pubic arch, iliac crests, sacral region, and of the interior of the pelvis by the rectum or vagina, will often serve to locate the seat of fracture. In fissures of the acetabulum the only symptom may be pain in the joint following a fall upon the feet or trochanter. This may be rendered acute by a blow upon the foot or knee. Fractures of the rim of the acetabulum are generally accompanied by dislocation of the head of the femur upward, which is easily reduced by traction but readily recurs. When the head is driven into the pelvis, there is flattening of the hip, and the head of the bone may sometimes be felt by rectal examination. In severe cases, when there is a complicating visceral injury, the shock is often so great as to mask other symptoms. In urethral injuries we may have retention or extravasation of urine. Hæmaturia is present in wounds of the bladder or ureter. In extensive intraperitoneal wounds of the bladder the viscus may be empty, the catheter withdrawing only a small quantity of blood. Intermittent hæmaturia suggests a wound of the ureter. Rectal bleeding is present in wounds of that organ or the sigmoid colon. Wounds of the iliac vessels are indicated by the gradual development of a semisolid retroperitoneal pelvic tumor, or by pallor, cold extremities, weak pulse, and other evidences of shock when the hemorrhage is within the peritoneal cavity.

The **treatment** in uncomplicated cases consists in the reduction of any deformity and the application of a dressing to secure immobility of the parts. The employment of a stout pelvic binder, or double plaster spica, is generally sufficient. Semiflexion of the thighs, the legs resting on one or two pillows placed under the knees, is a comfortable position for the patient. Tying the legs together may be necessary if the fragments are loose and easily displaced. If there is evidence of vesical injury or severe hemorrhage, laparotomy should be performed to locate the seat of the hæmatoma and to repair any intraperitoneal injury, after which the peritoneum should be closed and the prevesical space opened, clots removed, vessels secured, bladder wound repaired, and the displaced fragments of bone, if present, reduced and held by sutures. Generous drainage should be employed in the suprapubic wound, and the bladder drained by a perineal tube.

In fractures of the tuberosities of the ischium, sacrum, or coccyx, no treatment is required other than rest, immobility, and the use of air cushions to prevent pressure on the loose fragments. In fracture of the rim of the acetabulum, extension, as in fractures of the femur, may serve to keep the head of the bone in the socket, although the prognosis is not favorable.

Fractures of the Scapula.

Fractures of the scapula are comparatively rare. The portion of the bone most frequently broken is the acromion process; next in frequency come the body and spine; fractures of the neck, coracoid process, and glenoid fossa are rare.

Acromion.—This fracture is generally transverse and situated just in front of the acromioclavicular articulation. It is due to a fall or blow on the shoulder, elbow, or hand, or to direct violence on the tip of the shoulder. Traumatic separation may take place at the epiphyseal line at any age, and it should be remembered that a failure of union of the epiphysis may occur which may lead to an error of diagnosis in a contusion of this region.

The **diagnosis** is usually made by observing a slight flattening of the shoulder, localized tenderness, and irregularity of outline on passing the finger along the edges of the bone, crepitus and abnormal mobility on raising the arm and shoulder. Voluntary abduction of the arm is painful and often impossible.

Bony union occurs only when the fragments are accurately replaced. This is often difficult to accomplish, and in the majority of instances the union is fibrous.

The **treatment** consists in the application of a dressing which pushes the humerus well upward and outward. The use of Moore's figure-of-eight bandage from the elbow to the opposite shoulder (Figs. 321 and 322) perfectly fulfils this indication.

Fig. 321.

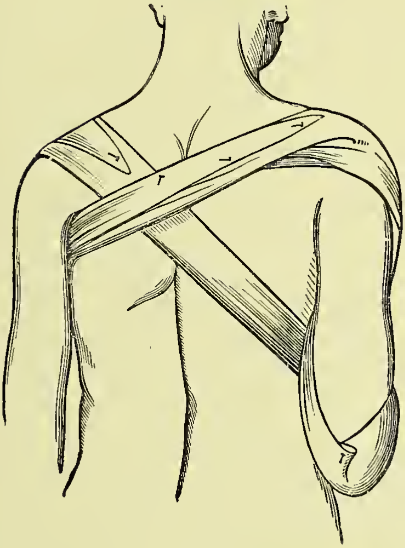
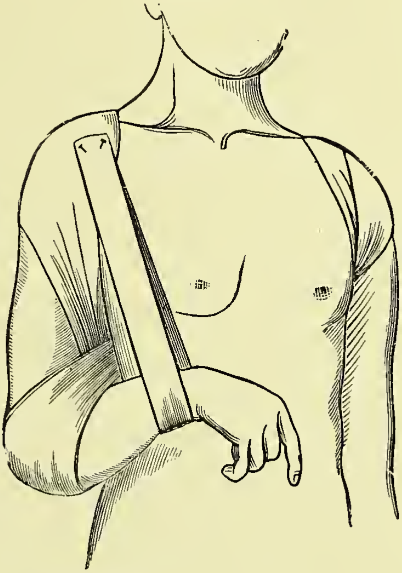


Fig. 322.



Moore's dressing for fractured clavicle.

Body and Spine.—Fractures of the body of the bone are generally due to direct violence. The line of fracture is commonly transverse; it may, however, be oblique or irregular, and occasionally assumes a longitudinal direction extending through the spine. Fractures of the supraspinous region are very rare. Isolated fracture of the spine is uncommon.

The **diagnosis** is established by direct palpation and by movements of the arm, revealing points of tenderness, irregularities in outline, mobility, and crepitus.

The **treatment** consists in reduction by manipulation and movements of the arm, and retention by the application of adhesive plaster straps or a snugly fitting binder and sling, as seen in Fig. 43.

Neck and Glenoid.—Fractures of the neck and glenoid are exceedingly rare. In the former the line of fracture may include the coracoid process or lie external to it; in the latter the fracture may be stellate. Epiphyseal separation of the neck, including the coracoid, is possible before the fourteenth year.

Diagnosis.—In fractures of the neck the signs are those of a subglenoid dislocation: flattening of the shoulder, prominence of the acromion, and the presence of the head in the axilla. Reduction is easily accomplished by raising the humerus, but the deformity is at once reproduced when the support is removed. These movements give rise to crepitus.

The **treatment** consists in reduction, which is easy, and retention of the fragments, which is difficult to accomplish. The application of Moore's figure-of-eight bandage (Figs. 321 and 322), or the sling and binder dressing, will be found useful. The writer on one occasion obtained a satisfactory result by the immediate application of a plaster-of Paris spica extending from the shoulder to the hand, the elbow flexed across the chest, and the humerus being pushed firmly upward and held in this position until the plaster hardened.

Coracoid.—Fractures of the coracoid process are generally due to direct violence, and are often associated with fracture of the clavicle or ribs. If the ligamentous attachments are ruptured, there may be a separation by action of the biceps, coracobrachialis, and pectoralis minor muscles.

Symptoms.—The signs are pain on motion and localized tenderness; crepitus may be felt if the fragments are not widely separated. Union is generally fibrous, but without functional disturbance.

The **treatment** should consist in the application of a Velpeau bandage (Fig. 55).

Fractures of the Clavicle.

The clavicle is fractured more frequently than any other bone in the body. By far the larger number of cases occur in childhood, although it is by no means infrequent in later life. The seat of fracture is commonest at the outer portion of the middle third, where the line is usually oblique. Next in frequency fractures occur in the outer third. Here they are apt to be transverse, with little or no displacement except at the outer end, where displacement may be marked. Fractures near the sternal end are rare, as is a separation of the epiphysis. The commonest cause of this fracture is indirect violence, as a fall on the shoulder, elbow, or outstretched hand, the muscles being rigid (an application of force which in later life frequently results in a dislocation of the shoulder). Direct violence is responsible for a considerable number of these fractures, and muscular action has been recorded in a few. Indirect violence produces the fracture by exaggerating the normal curves of the bone, which results in the oblique direction of the break. The inner fragment is pulled upward by the action of the sternomastoid muscle; the outer fragment falls downward and forward by the weight of the unsupported shoulder.

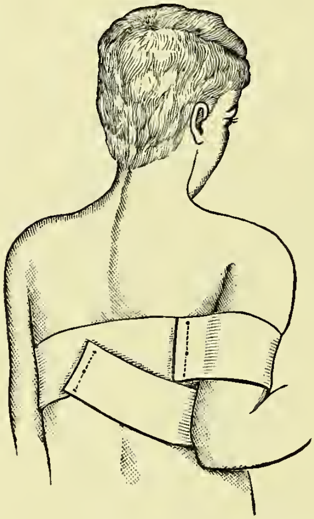
Complications in this fracture are rare. The fracture may be compound, double (generally in the middle third), or comminuted. Occasionally the fragments are driven inward, injuring the trunks of the brachial plexus or subclavian vessels. In the former condition a more or less complete and persistent paralysis of motion or sensation may result from pressure or secondary neuritis; in the latter, extensive hæmatomata or arteriovenous aneurism may occur, requiring immediate or remote surgical treatment.

The **diagnosis** of fracture of the clavicle is usually easy. The patient sits or stands with the head inclined toward the injured side, the shoulder lowered, and the elbow supported by the sound hand or resting upon the knee. All movements of the shoulder are painful. On palpation bony irregularity, localized tenderness, and crepitus can be readily appreciated. In transverse fractures of the outer third without displacement localized tenderness and pain on motion of the shoulder may be the only signs. In a fracture of the inner third the deformity may resemble a dislocation of the sternal extremity.

The **prognosis** in fracture of the clavicle is usually favorable, union taking place in the great majority of cases in from three to five weeks. There is, however, a certain amount of permanent deformity in the majority of cases, due to shortening and overriding of the fragments. Delayed union or failure of union may result from comminution and separation of the broken ends by bone fragments, clots, or shreds of tissue.

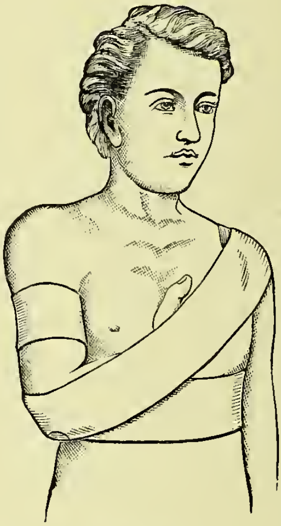
The **treatment**, to be successful, must first effect a complete reduction of the deformity and then maintain the fragments in this position until union has occurred. This is by no means easy. Probably the best result could be obtained by keeping the patient in the dorsal recumbent posture with a small pillow between the shoulders, but this in the great majority of instances would be wholly impracticable. As the chief deformity is due to the action of the sternomastoid muscle in elevating the inner fragment, and to the dropping downward and inward of the shoulder and outer fragment, producing an overriding, reduction is accomplished best by carrying the elbow backward and upward; this carries the outer fragment outward and upward, and at the same time renders tense the clavicular fibres of the pectoralis major, thereby opposing the action of the sternomastoid. This position is easily maintained by the application of Moore's figure-of-eight bandage from the elbow to the opposite shoulder (Figs. 321 and 322). This dressing, if properly applied and frequently inspected to prevent slipping from the shoulders and loosening, gives by far the best results of any apparatus or method of dressing known to the writer. Perhaps the dressing most frequently employed and, on the whole, the most desirable when the patient cannot be frequently seen and examined, is the Sayre dressing shown in Figs. 323 and 324, which consists of two strips of adhesive plaster, one encircling the arm about its middle and carried backward around the body, the other passed around the elbow and opposite shoulder. The first acts as a fulcrum; the second, by drawing the elbow forward and upward, forces the shoulder upward and backward.

Fig. 323.



First piece.

Fig. 324.



Second piece.

Sayre's adhesive plaster dressing for fracture of the clavicle.

The Velpeau bandage has also been extensively employed, but as it always tends to increase the deformity it is not to be recommended. When the conditions are such that some measure of deformity cannot be avoided, the simple sling and body-binder will be found useful (Fig. 65).

Union with deformity or delayed union can be successfully treated by an open operation, accurate reduction, and suture of the fragments with chromicized catgut.

Fractures of the Humerus.

Fractures of the humerus are less frequent than fractures of the clavicle or forearm, and are conveniently divided into three main groups: fractures of the upper extremity, shaft, and lower extremity.

Fractures of the upper extremity include those of the *anatomic neck*, intracapsular, above the tuberosities, which are very rare; those of *one or both tuberosities*, associated with a line of fracture through the anatomic neck, somewhat more frequent; those of the *greater* or *lesser tuberosity* alone, very rare, and generally associated with dislocation; those of the *surgical neck*, which include all of those lying above the attachment of the pectoralis and teres major and below the epiphyseal line, and which constitute by far the greater number of fractures of the upper extremity of the bone; and *separations of the upper epiphysis*, which may occur before the twentieth year. Fractures of the anatomic neck, with or without involvement of the tuberosities, are generally due to falls or blows on the shoulder; those of the surgical neck may be produced by direct violence, by falls upon the elbow, or by cross-strain, the arm being fixed by muscular action, the injury generally taking place on the outer side of the bone, or by forcible rotation of the bone.

Diagnosis.—This in fractures of the anatomic neck may be impossible, as no deformity exists, and the only sign may be pain in the joint increased by motion (Stimson). Fracture of the anatomic neck, however, may be assumed when there are pain and crepitus high up in the joint without deformity, when the tuberosities rotate with the shaft, and when fracture of the glenoid, coracoid, or acromion can be excluded.

If tenderness over the tuberosities exists, crepitus, and an evident thickening of the bone in this region, fracture of the anatomic neck involving one or both tuberosities may be assumed; if no crepitus can be obtained and there is a slight shortening, the fracture is probably impacted.

In fracture of the greater tuberosity alone there are localized tenderness and crepitus, with pain on outward rotation. It is generally associated with dislocation of the head.

In fracture through the surgical neck the deformity is usually characteristic; there is angular deformity of the arm just below the point of the shoulder, caused by the drawing inward of the lower fragment by the pectoralis major, and the slight flexion and rotation outward of the upper fragment by the muscles attached to the tuberosities. The lower portion of the arm is usually abducted and supported by the opposite hand of the patient. The shoulder is lowered, but not flattened as in dislocation, and the acromion is not prominent. Localized pain and crepitus are easily obtained by palpation at the point of injury while gently rotating the bone from below, and this rotary motion is not shared by the tuberosities. Shortening is usually noticeable from drawing upward of the lower fragment, the point of which can often be felt under the skin in the axilla or, rarely, under the coracoid. Dislocation can be positively excluded by feeling the head of the bone in place, by a fulness instead of a flattening just below the acromion, and by placing the hand on the opposite shoulder and noting that the elbow can easily be made to touch the wall of the thorax.

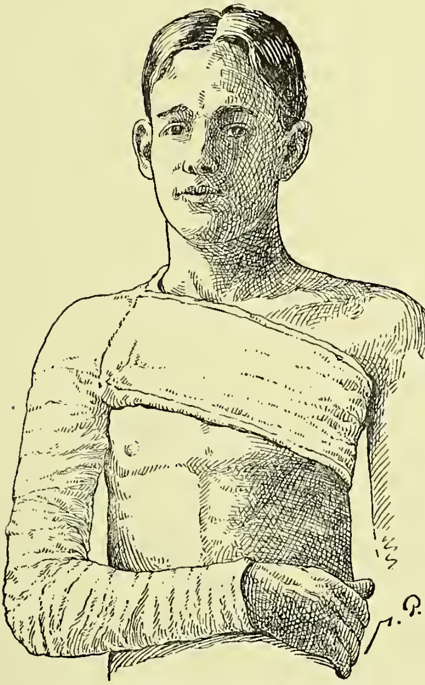
Complications.—Injury to the large vessels and nerve-trunks of the axilla by the sharp lower fragment of bone has been reported, giving rise to more or less extensive circulatory, motor, and sensory disturbances of the arm, the latter due to direct injury of the nerves, to a subsequent neuritis, or involvement of the nerve in the callus. The association of fracture in this region with dislocation or with injury to other neighboring bones may render the diagnosis obscure and present many difficulties in treatment.

Prognosis.—In the absence of complications fracture at the upper extremity of the humerus is an injury in which a good functional result may be expected, bony union taking place in the majority of instances in which satisfactory reduction has been effected. Exuberant callus and bony outgrowths may occur occasionally, especially in fractures involving the tuberosities, and may give rise to permanent limitation of motion.

Treatment.—In all doubtful cases general anæsthesia should be induced and a careful examination made. In fracture of the anatomic neck without displacement all that is necessary is to immobilize the arm and protect the parts from further injury. This is accomplished best by the use of the sling and body-binder, as shown in Fig 43.

Fractures through the tuberosities, if impacted, should be left undisturbed if motion of the joint is not hindered, and may be treated by the same simple method, or by the internal angular splint with or without a shoulder-cap. Fractures through the surgical neck, high up, may present little or no displacement, and be treated similarly, but in the great majority of instances fractures of the surgical neck require for their treatment some apparatus which combines extension with a firm grasp of the fragments, together with fixation of the shoulder- and elbow-joints. In the writer's experience these conditions are fulfilled best by the use of a plaster-of-Paris spica extending from the shoulder to the wrist, the elbow being flexed at a right angle (Fig. 325). The method of application is as follows: Two strips of adhesive plaster are placed longitudinally on either side of the lower half of the upper arm, the ends hanging free below the elbow. The upper part of the thorax, shoulder, and arm are next enveloped in two or more layers of sheet wadding; firm extension is then made by an assistant on the traction straps to overcome shortening, and the plaster rollers are applied in the usual manner. Extension is maintained until the plaster is hardened. This dressing is applicable to all fractures of the humerus in which a tendency to recurrence of the deformity is present.

FIG. 325.



Plaster spica, arm and shoulder.

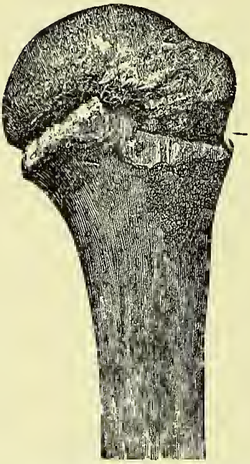
In epiphyseal separation of the upper extremity of the humerus the deformity is characteristic, owing to the projection of the anterior sharp margin of the lower fragment an inch below the acromion, the posterior margin of the shaft being lodged in the concavity of the upper fragment (Figs. 326 and 327). Reduction of the deformity is accomplished best by raising the arm anteriorly above the head (Moore), after which the fragments are kept in place by the plaster-of-Paris spica, the arm being elevated and slightly abducted.

It occasionally happens in fractures about the shoulder-joint, particularly in epiphyseal separations, and in fractures complicated by dislocation of the head, that open operation is to be recommended when the ordinary methods of manipulation fail to effect reduction. The region of the joint is best exposed by a vertical incision extending from the anterior border of the acromion downward for about four or five inches, separating the fibres of the deltoid muscle. If more room is needed, the attachment of the anterior fibres of the muscle to the clavicle may be divided and the muscle flap turned toward the median line.

Fractures of the shaft of the humerus are quite common, and are due to direct and indirect violence and to muscular action, the latter cause being more frequently observed in this fracture than in fracture of other long bones.

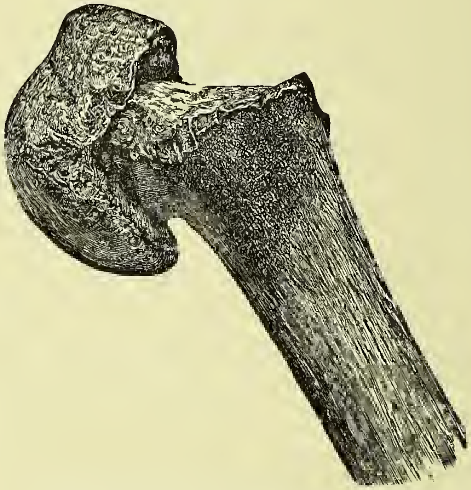
The line of fracture may assume almost any direction, but is more commonly transverse. Displacement is often considerable, and extensive injury to the soft parts is frequent, with occasional lesion of the musculospiral nerve and larger bloodvessels. Delayed union and failure of the bone to unite are more frequently observed in fractures near the middle of the humerus than in any other bone of the body, due to separation of the fragments by strips of muscle or fascia, or to imperfect immobilization of the parts. This fact and the possibility of paralysis from musculospiral nerve injury should always be remembered in making a prognosis.

Fig. 326.



Upper epiphysis of the humerus at ten years; separated by maceration. Outer side. (Moore.)

Fig. 327.



Separation of the upper epiphysis of the humerus; displacement forward of the lower fragment. (Moore.)

The **diagnosis** is easily made, as deformity, abnormal mobility, and crepitus are readily appreciated.

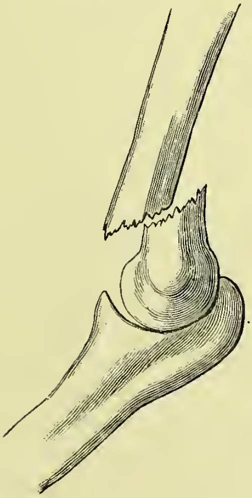
Treatment.—If much swelling exists, or if the soft parts are extensively bruised, rest on a pillow or the use of the sling and body-binder should be employed for a few days, together with an aluminium acetate wet dressing; later, reduction should be effected and the fragments held in place by a plaster-of-Paris spica from the shoulder to the wrist, the elbow being flexed across the body (Fig. 325). The use of an external plaster-of-Paris splint moulded over the shoulder and extending to the hand is lighter and often quite as serviceable. Internal angular splints alone are to be condemned, as they always allow a certain amount of motion between the fragments.

The treatment of compound fractures in this region differs in no respect from those of other long bones.

Fractures of the lower extremity of the humerus are divided into five classes: transverse fractures above the condyles; T-fractures into the joint; fractures of the external condyle; fractures of the internal condyle; and epiphyseal separations. In all of these varieties of fracture the cause is direct or indirect violence, generally falls or blows upon the hand or elbow. They are more frequent in children than in adults.

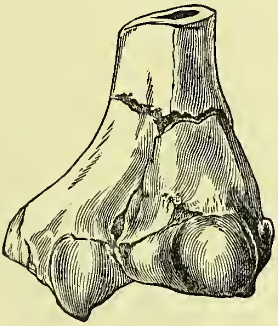
Diagnosis.—In fracture above the condyles the direction is generally transverse from side to side, but oblique from above and behind downward and forward (Fig. 328). The lower fragment is drawn backward and upward by the action of the triceps, and the upper fragment projects downward, making a prominence in front, just above the joint-line. This backward displacement of the lower fragment creates a deformity somewhat resembling that

Fig. 328.



Supracondyloid fracture. (Stimson.)

Fig. 329.



T-fracture of humerus. (Helferich.)

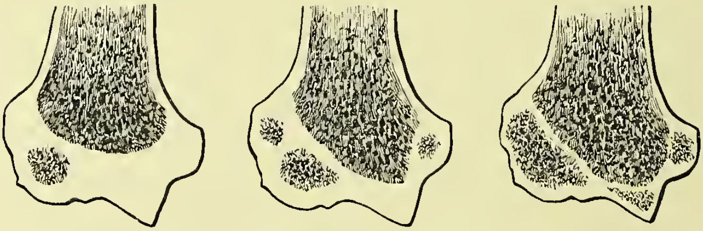
produced by a backward dislocation at the elbow. The points in differential diagnosis are: The normal relations of the epicondyles and olecranon, ease of reduction, tendency to a return of the deformity, the projection in front of the joint above the joint-line being rough and irregular, and the presence of crepitus. An anterior or lateral displacement of the lower fragment may occur, giving rise to atypical deformities.

In the T-fracture, in addition to the transverse line of fracture above the condyles, there is a line of separation extending from this to the articular surface (Fig. 329). As this fracture involves the joint, there is, in addition to the signs of the supracondyloid fracture, an increase in distance between the two epicondyles, separate mobility of each condyle, and an effusion into the synovial cavity.

In fractures of the *external condyle* the line of fracture may be wholly external to the joint (fracture of the epicondyle), or it may pass obliquely into the joint from a point just above the epicondyle. The same is true of fractures of the internal condyle. In the former the diagnostic points are pain on motion, tenderness over the outer side of the joint, separate mobility of the external condyle, crepitus, and a tendency to abduction of the forearm. In the latter the same signs are present on the inner aspect of the elbow and a tendency toward adduction of the forearm.

If the displacement is slight, the relation of the epicondyles and olecranon may not be altered; generally, however, the fractured epicondyle is somewhat higher than its fellow, and in the case of the internal condyle there is often a displacement backward due to the upward traction of the ulna by the triceps.

FIG. 330.



First to second year. Eighth to twelfth year. Twelfth to fifteenth year.

Ossification of the lower epiphysis of the humerus. (Stimson.)

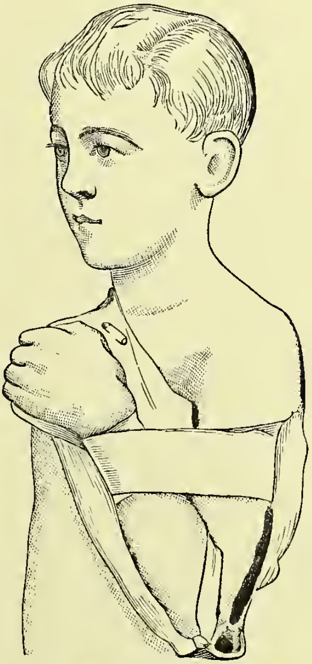
Epiphyseal separations are rare, occur at an early age, and generally consist in a separation of the articular surface below the epicondyles. (Fractures of the articular surface have also been reported in later life.) As these fractures lie within the capsule of the joint the tendency to marked deformity is slight. The signs are slight backward displacement, which is easily corrected, and is as easily reproduced; muffled crepitus, and finding the epicondyles attached to the shaft of the bone.

A study of the development of the lower extremity of the bone, as described by Henle and shown by Stimson in Fig. 330, will show that in very early life a separation may occur which will include the epicondyles in the lower fragment. At a later period the line of separation must be below the internal epicondyle, but may be above the external epicondyle. It is not improbable that in many of the injuries described as fractures of the external condyle occurring before the seventeenth year the lesion is a separation through the cartilage connecting the shaft with the ossified epicondyle and capitellum.

Complications.—Fractures at the lower end of the humerus are rarely compound. They are occasionally comminuted, and not infrequently are accompanied by injury to the ulnar or musculospiral nerve, the former more commonly in fracture of the internal condyle, the latter in those of the external condyle.

Treatment.—In all of these fractures the diagnosis should be verified by an examination under general anæsthesia or with the *x*-rays. Reduction is generally easy, but difficult to maintain. In transverse fractures, supracondyloid and epiphyseal, reduction is accomplished by traction in a flexed position; this position should be maintained by the application of an internal angular splint. In T-fractures and fractures of the internal or external condyle Cotton advises dressing the arm in an acutely flexed position. This position, with pressure on the epicondyles, serves to reduce the fracture, and should be maintained by a strip of zinc oxide plaster passed around the wrist and upper part of the arm (Fig. 331). The flexed arm is then placed snugly against the chest-wall on a gauze pad, and held in place by a broad bandage of folded muslin applied as shown in Figs. 332 and 333. The use of a plaster-of-Paris bandage extending from the shoulder to the wrist

Fig. 331.



Arm dressed in the acutely flexed position.

Fig. 332.

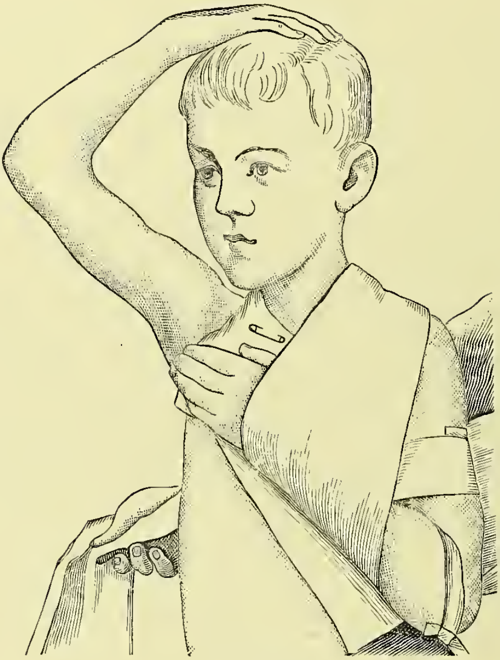
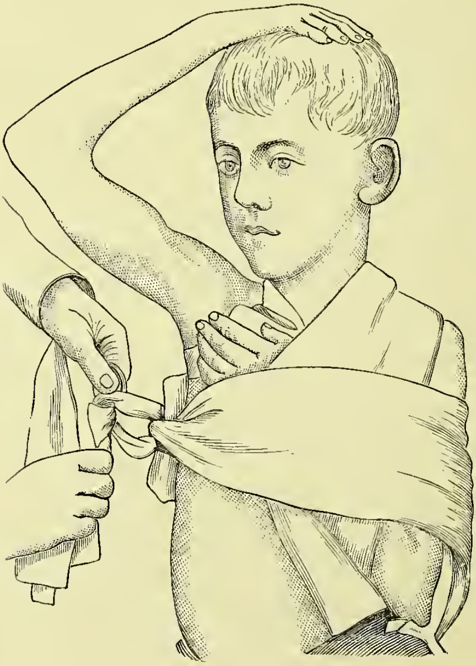


Fig. 333.



has many advantages, especially in young children. In any case it is desirable after the application of the dressing to examine the parts with the x-rays. If the fracture cannot be properly reduced by manipulation, it is advisable to make an incision and remove the obstacle to complete reduction (generally a strip of muscle or fascia). The fragments can then be accurately reduced and held in place by a chromicized catgut suture.

When reduction is perfect, union is rapid, and if the joint is not involved, a good functional result may be expected. In all fractures extending into the joint passive motion should be practised early and persistently. It may be commenced at the end of two weeks, should be employed every other day at first, and later every day if there is much limitation of motion. The combination of passive motion and massage will be found useful in most cases. Limitation of motion at the elbow after fracture is generally due to mechanical obstruction from misplaced fragments, to a deposit of callus in the olecranon or coronoid fossa, or to inflammatory adhesions in the joint. Considering the frequency of these complications, the prognosis in every case should be guarded.

Operative treatment of fractures of the lower end of the humerus may be necessary, to effect reduction of the fragments when, for any reason, such reduction cannot be brought about by the ordinary non-operative methods; to remove non-viable fragments of bone; to relieve nerve pressure or to increase the range of motion after vicious union has occurred. The seat of fracture is best exposed by one or two longitudinal incisions, preferably made on the posterior aspect of the joint parallel with and about 1 cm. from the edge of the olecranon. When the seat of fracture is exposed the bones should be accurately readjusted, and held in place by sutures of chromic gut, silver or phosphor-bronze wire, bone or ivory pegs, or simply by the position of the extremity. The joint wound should then be closed, as a rule, without drainage, and a plaster-of-Paris cast applied. Passive motion should be commenced as early as the second week, and massage as soon as the fragments have sufficiently united to prevent easy displacement.

Fractures of the Forearm.

Fractures of the forearm are commonly divided into those occurring near the elbow, those occurring in the shaft of one or both bones, and those occurring near the wrist-joint.

Fractures in the neighborhood of the elbow-joint are those of the olecranon, coronoid process, and of the head and neck of the radius.

Fractures of the olecranon are of comparatively frequent occurrence. They result commonly from falls or blows on the elbow, from muscular strain, or from both causes combined. If the fracture occurs near the shaft of the bone, there may be only a slight separation, the fragment being held in place by the muscular and aponeurotic attachments. Generally, however, the detached fragment is drawn upward by the triceps, and a distinct sulcus is present which can easily be appreciated by the examining finger.

The **diagnosis** is established by the presence of localized pain and tenderness, abnormal mobility of the separated fragment, swelling of the joint, and inability to extend the forearm fully. Crepitus is generally absent, owing to separation of the fragments.

The **treatment** consists in fixation of the arm in a partially extended position. As complete extension is more or less uncomfortable to most patients, a slight flexion to 15 or 20 degrees may be allowed. All attempts by bandages or adhesive straps to overcome the powerful action of the triceps muscle in drawing the loose fragment upward are useless, and only serve to constrict the soft parts and favor œdema. If any appreciable degree of separation is present, the union is always fibrous, and the separation of the fragments may be increased by the later use of the arm. In spite of this separation the functional result is usually satisfactory.

In the event of a wide primary separation of the fragments, with considerable hemorrhage into the joint, and especially if there is evidence of other obscure injury of the joint, open incision, thorough inspection, and suture of the fragments, are to be recommended if the conditions are such as to insure the possibility of perfect surgical technic.

Fractures of the coronoid process are rare and almost always associated with a backward dislocation of both bones.

The **symptoms** characteristic of this condition are: A backward dislocation at the elbow, which is reduced with more than ordinary ease, but in which a tendency to redislocation is marked, and the presence of a small fragment of bone in front of the joint, drawn upward by the action of the brachialis anticus muscle. Crepitus is rarely obtained except in the position of extreme flexion.

The **treatment** of this fracture consists in reduction of the dislocation and immobilizing the arm in a flexed position, the degree of flexion necessary being determined by the point at which crepitus can be obtained, generally somewhat more than at a right angle.

Fractures of the upper extremity of the radius may be limited to the head, stellate fissures, or complete separation of a fragment; or they may involve the neck of the bone, in which case they are generally transverse. They may occur alone as a result of direct violence, but are more commonly associated with a dislocation or other severe injury.

The **diagnosis** is often uncertain unless confirmed by a radiograph or incision. The symptoms suggesting the lesion are pain, localized tenderness, and crepitus on motion without marked deformity. Marked limitation of flexion, pronation, and supination may be occasioned by the presence of a loose fragment of the bone in the joint-cavity.

In these cases the **treatment** should be open incision, thorough inspection, and removal of any fragment of bone. Excision of the head of the bone may be required if there is much comminution. The incision which best exposes this portion of the joint is the posterior longitudinal one, made just to the outer side of the olecranon.

If no deformity exists and little or no limitation of the normal movements, fixation of the elbow at a right angle is all that is required in the way of treatment.

As in all fractures involving the elbow-joint, early massage and passive motion are essential.

Fractures of the shaft of one or both bones of the forearm are of frequent occurrence, and are usually produced by direct or indirect violence. Fractures of the ulna alone are slightly more frequent than those of the radius alone, and are almost always produced by direct violence, as a blow upon the outer aspect of the arm when that member is raised to guard the face in boxing. Fractures of the shaft of the radius are often the result of direct violence, but are more generally produced by indirect violence, as a fall on the hand. Muscular action alone is rarely responsible for these fractures. When the ulna alone is broken the displacement is often slight, unless the injury is complicated by a dislocation of the head of the radius, in which event the displacement may be considerable, and its direction is more influenced by the fracturing force than by the action of muscles. In fractures of the radius above the insertion of the pronator radii teres muscle the upper fragment is drawn upward and outward by the biceps; in fractures below that point the tendency of the fragments is toward the ulna, the upper one being often drawn upward by biceps influence. In fractures of both bones almost any variety of displacement may be present, the fracturing force being, as a rule, a more potent agent in its production than action of the muscles.

Diagnosis.—Fractures of the forearm occurring in the shafts of the bones are more readily recognized than those at either extremity. If both bones are fractured, there is, as a rule, considerable angular deformity of the forearm, either present or easily produced; localized tenderness, false motion, and crepitus are easily elicited, and shortening is generally present. In fractures of the radius alone some deformity is often present, due to the upward traction of the biceps on the upper fragment. On pronation and supination the rotation is not communicated to the head of the bone, and there is always to be found a local point of tenderness, generally with crepitus. In fractures of the shaft of the ulna localized tenderness may be the only symptom. The use of the x-rays is of great value in these cases, not only for diagnosis, but also in treatment, for accurate reduction in these cases is essential to insure a satisfactory functional result.

Complications.—In perhaps no fractures in the body are circulatory disturbances as frequent as in fractures of the forearm. They are generally due to faulty application of the splints and dressings, and result in local sloughs, ischæmic paralysis of the muscles, and occasionally gangrene of the extremity. Delayed union and failure of union are to be feared if the reduction has been imperfect, and a temporary or permanent impairment of the function of pronation and supination frequently follows, not only from faulty reduction, but also from exuberant callus when the muscles, periosteum, and interosseous membrane have been extensively lacerated.

Treatment.—When possible, fractures of the forearm should be examined, reduced, and the dressings applied under the guidance of the x-rays, so great is the importance of accurate coaptation of the fragments. Of course, in the majority of instances this is not practicable, and reliance must be placed upon the correction of the apparent deformity and the restoration of function. When reduction has been effected, which often requires considerable force, the arm should be flexed at the elbow and the hand placed in a position midway between pronation and supination, with the thumb pointing upward. Retention in this position should at first be accomplished by two well-padded wooden splints loosely strapped in place, extending from the elbow to the fingers, and surrounded by a muslin bandage. The arm should be placed at rest on a pillow or confined to the side by a sling and thorax-binder. Care should be taken that the splints are wide enough to extend a trifle beyond the fleshy part of the arm, to avoid lateral compression by the bandage. The use of a pad or graduated compress between the bones to prevent lateral approximation, is of no value, and serves only to compress the soft tissues and favor arrest of circulation. The parts should be frequently inspected to avoid the possibility of strangulation. After the swelling has subsided the use of a plaster-of-Paris dressing from the shoulder to the palm is to be advised. Inspection of the parts by the fluoroscope after the application of the final dressing is to be recommended whenever possible.

In fractures of the radius above the insertion of the pronator radii teres, if there is a marked tendency to supination of the upper fragment which is not corrected by flexing the elbow, it is desirable to dress the arm in a position of greater supination than normal. Extreme supination is to be avoided, as it causes much discomfort to the patient. In the event of failure to reduce the deformity or to bring about accurate coaptation of the fragments, open operation, accurate replacement, and suture, are to be advised.

Fractures in the Vicinity of the Wrist-joint.—These are fractures at the lower end of the radius (Colles' fracture), fractures of both bones just above the wrist, and fractures of the styloid process of the radius or ulna.

Colles' fracture, named after the Dublin surgeon who first accurately described the injury, consists in a fracture through the radius just above its inferior articular surface. The line of fracture usually occurs at the point where the shaft of the bone begins to widen into its inferior extremity, as this is the weakest part of the bone, owing to the fact that the hard compact outer covering is largely replaced by soft, friable cancellous tissue before the bone expands into the bulky inferior extremity.

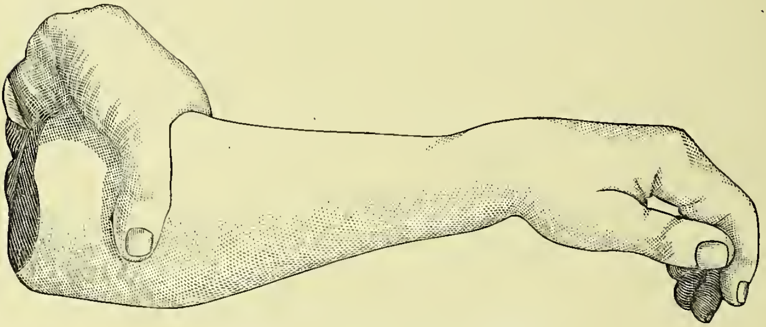
In the majority of instances this fracture is caused by a fall on the outstretched hand, producing forcible overextension at the wrist. This results, first, in a fracture at the weakest point, the general direction of which is usually transverse, the loose fragment being driven upward with the carpus, making with the upper fragment an angle the apex of which is directed toward the flexor surface of the arm. Impaction of the upper fragment into the comparatively soft tissues of the lower is common. After fracture of the radius the remaining force of the injury is received by the carpal attachments of the ulna, which usually give way, producing a displacement downward and outward of the lower extremity of that bone, with rupture of the internal ligament, and occasionally of the triangular fibrocartilage and styloid. This injury is practically always present, is often overlooked, and if uncorrected gives rise to permanent deformity and weakening of the wrist.

Occasionally fracture at the lower end of the radius is produced by a fall or blow on the back of the hand, causing exaggerated flexion. This fracture, which has been carefully studied by J. B. Roberts, of Philadelphia, presents a deformity which may be described as the opposite of that found in typical Colles' fracture, the lower fragment being driven downward and upward, causing with the upper an angle the apex of which points upward. Since the general adoption by surgeons of *x*-ray examinations in fractures, those occurring at the lower extremity of the radius have been found to present great variation in the line or lines of fractures and in the position of the fragments. The studies of Codman, of Boston, and of Beck, of New York, have demonstrated that the typical Colles' fracture, as described above, occurs in only about one-half of the cases, the other recognized forms being an oblique fracture through the base of the styloid process, an oblique fracture of the inner angle of the radius, epiphyseal separations, transverse and stellate fractures without displacement, and comminuted fractures. Fracture of the ulnar styloid is frequently present.

Fracture of both bones above the wrist is very uncommon.

Diagnosis.—In a typical Colles' fracture the deformity is strikingly characteristic (Fig. 334). There is radial shortening, giving the hand an inclination toward that side; the lower fragment and carpus project upward, while the upper fragment is pushed downward, giving an appearance which has been described as "the silver-fork deformity"; the lower extremity of the ulna is displaced outward and downward, which widens the wrist at that point. On palpation, the tip of the radial styloid will be found on a level with that of the ulna or a little above it (normally it lies one-fourth of an inch below); the angular deformity is easily appreciated; there is tenderness over the line of fracture and in the region of the ulnar styloid. If the fracture is not impacted, abnormal mobility and crepitus are easily obtained. The ability to extend the hand is retained, while flexion is limited. The arm is usually pronated; supination causes pain. In Roberts' fracture by hyperflexion, the apex of the angular deformity points upward, and extension of the fingers and hand is limited and painful. In transverse fractures without displacement of the fragments no deformity may be present. Fractures of both bones or of either styloid are easily recognized by localized pain, abnormal mobility, and crepitus.

Fig. 334.



Deformity in Colles' fracture. (Stimson.)

Complications.—Compound fractures in this region are exceedingly rare; when present, they are generally accompanied by extensive laceration of the soft parts with opening into the joint or synovial tendon-sheaths, resulting, if infected, in permanent stiffness and loss of function. Extensive comminution or destruction of the cancellous bone-tissue by impaction of the fragments may prevent complete reduction and result in permanent deformity. Ischæmic wasting of the muscle from pressure of splints or bandages is common after this fracture and delays restoration of function. Chronic rheumatic arthritis frequently follows this injury in those predisposed to this affection.

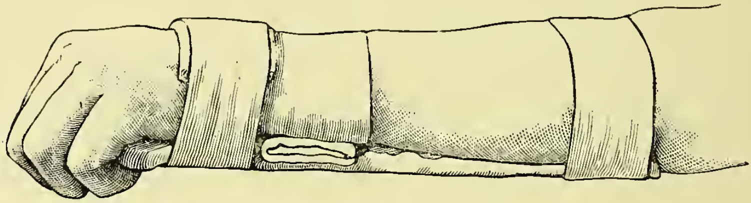
Prognosis.—While perfect restoration of function is to be expected when reduction has been complete, it should be remembered that this is often delayed, and stiffness of the carpal and phalangeal joints frequently remains for a long period, and requires persistent efforts on the part of the patient for its removal. A certain measure of deformity also results in the majority of instances, due to incomplete reduction of the angular deformity, to loss of substance from impaction, or to failure completely to restore the displaced ulna. Fortunately, however, the persistence of deformity does not necessarily entail a loss of function, for a satisfactory restoration of function generally follows, though perhaps tardily, even in cases of permanent and marked deformity. In uncomplicated cases bony union may be expected in four weeks. In aged and rheumatic subjects complete functional recovery is delayed, and often never realized.

Treatment.—As this is one of the most frequent of fractures, and as the results of treatment are, in perhaps the majority of instances, imperfect, it is not surprising that such a large number of splints and devices for treating this injury should have been invented and advocated. The secret of success lies in early and complete reduction of the deformity when this is possible, and not in the kind of retention apparatus used. When perfectly reduced, there is little tendency to a reproduction of the deformity, and any simple dressing which protects against subsequent injury and keeps the parts at rest will meet the indications.

The use of specially constructed splints to hold the hand in some abnormal and strained position, as the old-fashioned pistol splint, is to be condemned; they are of no value in preventing a recurrence of the displacement, and often produce permanent weakening of the wrist by stretching otherwise uninjured ligaments and tendons.

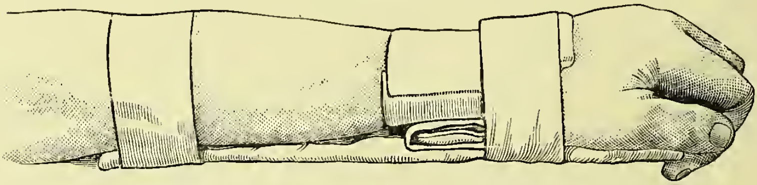
Reduction is accomplished best by grasping the injured hand as in the act of shaking hands. The hand is then drawn strongly toward the radial side to disengage the ulnar styloid, which is often caught in the torn lateral ligament. The hand is then slowly brought back to a line with the arm, strong extension being made by the surgeon, while counterextension is maintained by an assistant holding the arm near the elbow. During this manœuvre the surgeon places the thumb over the carpal end of the lower fragment and two fingers under the lower end of the upper fragment, and by pressure upward and downward on these two points, and an up-and-down motion of the hand, breaks up the impaction, if present, and pushes the lower fragment into place. If the depressed ulnar end has not been reduced by this manœuvre, an effort is made to push it up into place. If there is a tendency for the ulnar displacement to be reproduced, which is not uncommon, this is prevented by placing a small pad or roller bandage under the head of the bone, and holding it in place by an encircling strap of adhesive plaster. To prevent passive congestion of the hand, this strap of plaster is immediately cut through on its radial side, which prevents constriction in the event of subsequent swelling. A straight palmar splint is then applied, extending from the elbow to the metacarpophalangeal joint, with a ball of cotton in the hollow of the palm. A pad of muslin is placed under the point of angular deformity, and another over the carpus; these and the splint are secured in place by adhesive straps (Figs. 335 and 336) and a light bandage applied. The arm is carried in a sling. In all save the simplest cases reduction should be effected under general anæsthesia, aided when possible by fluoroscopic examinations.

Fig. 335.



Author's dressing for Colles' fracture. (Ulnar view.)

Fig. 336.



Author's dressing for Colles' fracture. (Radial view.)

The use of a plaster-of-Paris palmar splint accurately moulded to the arm and hand will do away with the necessity of pads and is a satisfactory dressing. When there are much comminution and considerable mobility of the fragments in restless children, and in alcoholic adults with the possibility of delirium tremens developing, the use of a well-padded plaster cast of the arm and hand is to be advised. If the soft parts are severely contused, and if much œdema follows the injury, the arm should be treated for several days by rest on a pillow and wet dressings without the use of a retention apparatus. In compound fractures in this region every effort should be made, by free incisions, removal of fragments, suture of the bone, and rigid antiseptic measures to save the arm.

Fractures of the Carpal Bones.

While injury to the carpal bones is comparatively rare, it has been found to be of more frequent occurrence than was supposed before the general use of the *x*-rays.

As the symptoms are often somewhat obscure, and as crepitus may be wanting, these injuries in the past were generally regarded and treated as bad sprains of the wrist. The classical paper of Codman and Chase,[1] however, has added much to our knowledge of the subject, and has given us a definite symptomatology of the more common forms of carpal injury.

Fracture of the scaphoid is by far the most frequent; that of the other bones comparatively rare. This injury is not infrequently associated with dislocation forward of the semilunar, and in these cases the proximal fragment of the scaphoid is often carried forward with the displaced semilunar.

Symptoms.—The symptoms of fracture of the scaphoid are the history of a trauma associated with forced hyperextension or, rarely, flexion of the wrist; the presence of pain and tenderness in the region of the tabatière; swelling of the radial half of the carpal region; and painful limitation of extension of the wrist. The *x*-rays may be necessary to establish the diagnosis, but it must be remembered in this connection that a bipartite variation in this bone has been demonstrated by Professor Dwight and others.

Treatment.—The treatment should consist in immobilization of the parts for at least four weeks. If at the end of this period union has not taken place, there is little hope for subsequent repair. Massage and passive motion, however, in the majority of instances will bring about a good functional result. If pain and stiffness continue after a reasonable period and are increased by normal use, the proximal fragment should be excised.

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[1] "Annals of Surgery," March and June, 1905.

Fractures of the other bones are rarely recognized except by the help of the x-rays. The same indications for treatment exist as in fracture of the scaphoid.

Fractures of the Metacarpal Bones.

These fractures are not infrequent. They are generally caused by direct violence, as a blow or fall on the back of the hand, or, more commonly, from striking some hard body with the closed fist. The latter so-called *punch fractures* are frequently encountered in boxers, and are said by Burrows to involve the base of the first and fifth metacarpals and the head or shaft of the others. Two or more of the metacarpal bones are often fractured by the same injury.

The **diagnosis** is generally easily established by recognizing the presence of tenderness, crepitus, and false motion by palpation. If there is considerable swelling over the back of the hand, and if the fracture is near a joint, the signs may be obscured or wanting. Localized tenderness on direct pressure, and pain on striking the injured extremity of the bone while the fist is closed, together with localized pain on flexion and extension of the corresponding finger, render the diagnosis probable.

The **treatment** of these fractures should consist in fixation of the wrist and hand, the fingers being left free to move to prevent stiffness. This is conveniently attained by the use of a palmar splint extending from the elbow to the metacarpophalangeal joint, the palm resting on a ball of yarn or cotton pad.

Fractures of the Phalanges.

As fractures of the phalanges are frequently due to direct violence, they are often compound. In simple fracture without displacement the diagnosis is not always clear, as it is often difficult to recognize or produce independent motion in short bones bounded above and below by very movable joints. Crepitus, however, can generally be obtained by firmly grasping and fixing the neighboring joint or joints, and making strong lateral movements.

Treatment.—In simple fractures without displacement or in which reduction has been effected, splints are rarely called for, the only treatment necessary being the application of a bulky dressing to avoid motion of the part. The employment in such cases of a bandage made of exceedingly thin gutta-percha tissue has been found the most satisfactory dressing. The small roller is first immersed in hot water, then applied to the fingers as an ordinary bandage, and when the part is covered by two or three thicknesses of the tissue the hand is immersed in cold water, which hardens the gutta-percha, making a light and sufficiently firm cast. When the gutta-percha tissue is not available, two or three layers of ordinary zinc-oxide adhesive plaster will answer the purpose. In compound fractures which have become infected amputation is generally necessary.

Fractures of the Femur.

As in fractures of other long bones, fractures of the femur are divided into three classes: fractures of the upper extremity, fractures of the shaft, and fractures of the lower extremity.

Fractures of the upper extremity of the femur include fractures of the *head*, extremely rare and generally associated with dislocation; fractures of the *neck*, very common, especially in the aged; fractures of the *neck* and *great trochanter;* fractures of the *greater* or *lesser trochanter*, and epiphyseal separations.

As fractures of the head alone or those of the greater or lesser trochanter are so rare as to constitute veritable surgical curiosities, we shall consider in this section only fractures of the neck with or without involvement of the greater trochanter.

It is the opinion of most modern authorities that the old classification into *intracapsular fractures* and *extracapsular fractures* of the neck of the femur should be abandoned for the following reasons: First, because a study of the attachment of the capsular ligament and the synovial sheath contained within it will show that while the anterior and inferior portions of the neck lie within the capsule, the posterior and superior portions lie partly within and partly without the capsule; that the synovial membrane does not extend to the line of attachment of the capsule to the bone, but is reflected from the capsule to the bone at a varying distance from the capsular attachment. Many fractures, therefore, lie partly within and partly without the capsule, and it is possible for a fracture to be at the same time intracapsular and extra-articular. Second, because it has been abundantly proved that many intracapsular fractures unite readily under favorable conditions. Third, because it is impossible clinically to differentiate the two varieties. Fourth, because it has been shown that union in this fracture depends upon the blood-supply of the upper fragment, which is received chiefly from periosteal vessels situated on the upper portion of the neck, and that this part of the periosteum often remains untorn in both intracapsular and extracapsular fractures without great displacement. The classification of these fractures into *fractures through the neck* and *fractures at the base of the neck*, suggested by Stimson, is far more rational, and should be generally adopted. In *fractures through the neck* the line of fracture is limited to the neck between its attachment to the head and shaft. Epiphyseal separations at the junction of the head and neck may occur before the seventeenth year. In fracture *at the base of the neck* the fracture follows the spiral and intertrochanteric lines, often with fissures running into the greater or lesser trochanter. Rarely the line of fracture may extend from the junction of the lower part of the neck to the shaft and run obliquely upward and outward, leaving the great trochanter attached to the neck.

In all of these fractures more or less impaction may occur, depending upon the character and direction of the fracturing force.

While these fractures may occur at any age, fully two-thirds occur after the sixtieth year, the predisposing cause being the bone atrophy of old age. The injury which results in these fractures in the aged is often surprisingly slight: a fall upon the hip or feet, or an effort to prevent such a fall; slight rotary motion of the body, the foot being accidentally arrested; or simply stepping unexpectedly to a lower level, may produce this fracture. In younger subjects considerably more violence is necessary. Whitman has recently called attention to the fact that fracture of the neck of the femur is of fairly frequent occurrence in infancy and childhood. The lesion is often overlooked for the reason that such injuries may produce only slight and temporary disability, the child walking about without much pain within a week or two following the trauma. Such fractures, which are probably incomplete, are followed by a progressively increasing amount of shortening and adduction, producing eventually typical examples of coxa vara. Epiphyseal separations or fractures involving a part of the epiphyseal line occur occasionally in older children, but are rarely encountered before the tenth year. As the fracture is wholly within the synovial membrane, and as the small upper fragment is freely movable, accurate reposition of the fragments is often impossible by manipulation. In these fractures also the disability is often surprisingly slight, a large number being diagnosticated and treated as contusions or the early stage of hip disease.

Diagnosis.—There is a history of a fall or other injury, with pain in and about the hip and inability to use the limb. On inspection, the patient lying on the back, there will be seen apparent shortening of the limb, eversion of the foot, slight flexion of the knee, and a fulness about the hip. The degree of eversion is best estimated, according to Bigelow, by the comparative ability to invert the two feet. Exceptionally inversion may be present at first, due to the direction of the fracturing force. Palpation will reveal the presence of tenderness about the hip, relaxation of the supratrochanteric portion of the fascia lata, abnormal resistance at a point just external to the femoral vessels, one inch below Poupart's ligament (Hennequin's sign), due to the prominent angle formed by the two fragments, which usually projects anteriorly.

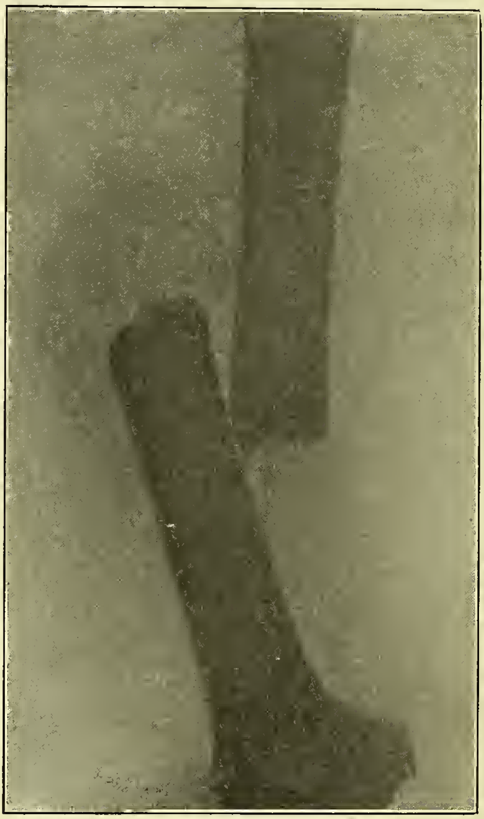
Mensuration will reveal an actual shortening of from one-half to three inches. This is ascertained by measuring from the anterior superior spinous process of the ilium to the tip of the inner malleolus, the legs being extended, parallel to and equidistant from the median line of the body; or by measuring the perpendicular distance from the tip of the great trochanter to a line encircling the body on a level with the two anterior superior spinous processes (Bryant's line); or estimating the height of the tip of the trochanter above a line drawn from the anterior superior spine of the ilium to the tuberosity of the ischium (Nélaton's line, which normally passes over the summit of the trochanter). The amount of shortening can be roughly estimated by measuring with the thumb and finger of each hand the distance from the anterior superior spines to the trochanters of each side.

Gentle downward traction, or rotation of the limb, causes pain and may elicit crepitus. Palpation of the trochanteric region during internal rotation of the limb may occasionally reveal the fact that the trochanter does not rise, but rotates on the axis of the shaft. Rotation of the trochanter through the normal arc does not, however, exclude fracture. Failure of the trochanter to rotate with the shaft indicates an oblique fracture through the trochanter.

In many cases following this injury in an elderly person the only symptoms are pain and inability to use the limb; and the only signs slight eversion (which may be due to simple contusion) and slight shortening, the shortening being within the limits of normal variation. In these doubtful cases it is far better to assume that a fracture is present or to wait for an *x*-ray examination, than to resort to extensive movements of the joint to elicit crepitus and render the diagnosis positive, for such movements not infrequently tear the periosteal bridge containing the vessels which nourish the upper fragments, and upon which repair of the injury will depend.

Prognosis.—A perfect result after fracture of the neck of the femur in an elderly person is not to be expected. By the older imperfect methods of treatment non-union was common and permanent disability the rule. While sufficient data are not at hand to make any very positive statement, the results reported by Whitman, Walker, and others of cases treated by the abduction method would seem to indicate that much better results are to be expected in the cases where this method can be carried out. It must be borne in mind, however, that union cannot take place by any method of treatment if the blood supply to the upper fragment is cut off, and as we have no data upon which to base an accurate opinion as to the resulting condition of nutrition of the upper fragment, the possibility of non-union should always be predicted. If there are great shortening, free motion, and abundant crepitus, the absence of a periosteal bridge and consequent non-union are probable. If, on the other hand, the shortening is slight, and there is evidence of impaction with slight displacement, the prognosis is more favorable. Under favorable conditions from six to eight weeks are required to bring about firm union.

Fig. 337.

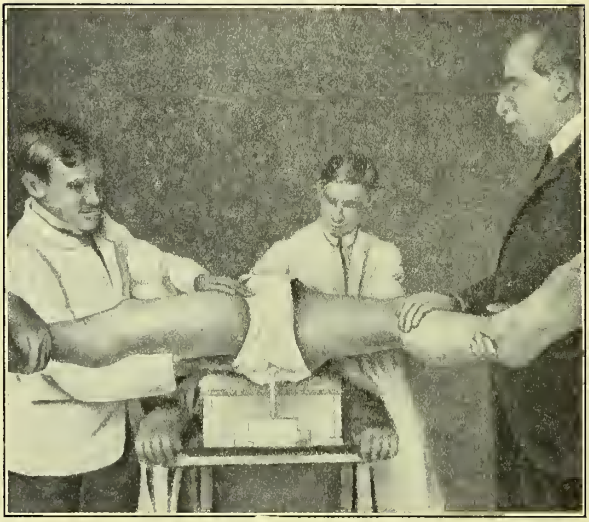


Fracture of femur.

Even when bony union has taken place marked impairment of function may be occasioned by persistent pain and stiffness of the joint, due to exuberant callus and rheumatic conditions. The ability to walk without pain has been observed when no union has occurred, a false joint being formed by thickening of the surrounding ligamentous structures. Death not infrequently results in the aged from fracture of the neck of the femur, the causes being shock and the development of hypostatic pneumonia during confinement to bed. In all cases of fracture of the neck of the femur in the aged the joint should be protected by the use of crutches for at least four months.

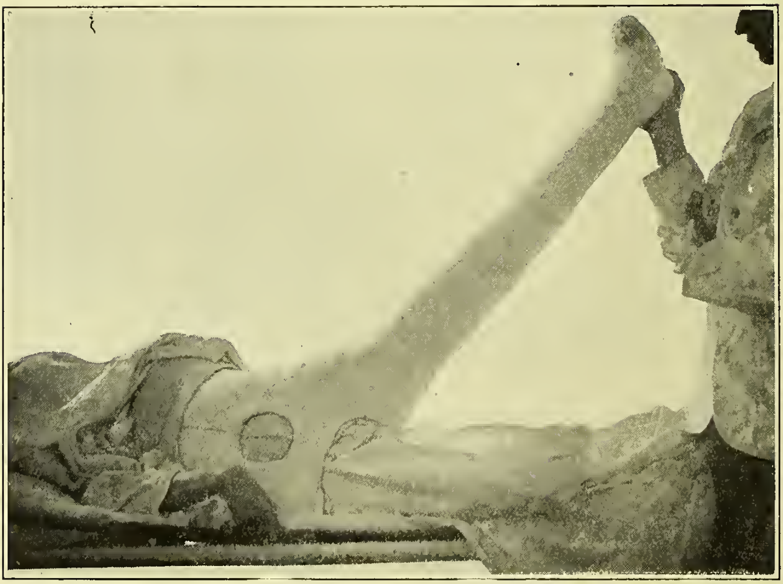
Treatment.—In cases which present the evidences of impaction—moderate shortening, limited motion, comparatively little pain, and no crepitus—no effort should be made either in the examination or subsequent treatment to correct the deformity. The patient should be kept in bed and the leg supported by sand bags or pillows, or, better, by the application of a long, well-padded side-splint extending from the axilla to the foot. In the cases which do not present evidences of impaction, or those in which there is considerable shortening with abnormal mobility, pain, crepitus, and muscular spasm, an effort should always be made to correct the shortening and to hold the limb in a position which will insure contact of the broken surfaces. This is accomplished best by the method advocated by Whitman, which consists in complete abduction and retention of the limb in this position by a plaster-of-Paris spica, extending from the lower border of the ribs to the toes. To accomplish this the patient should be etherized and placed on a table, the head and upper part of the trunk resting on an elevated platform made of a thick mattress or box covered with a blanket, and the sacral region supported by a hip rest (Fig. 338). Shortening should next be overcome by traction, and both legs gradually abducted to about 45 degrees. During this manœuvre the pelvis should be firmly held and upward pressure made on the trochanteric region, while an assistant overcomes the outward rotation of the limb by holding the foot in a perpendicular position. In this position of extreme abduction the two fragments are brought into apposition, and the normal obliquity of the neck is re-established (Fig. 339). In applying the plaster great care should be exercised to have an even layer of sheet wadding over the entire area to be covered, and an extra layer of the wadding should be placed over the bony prominences. Large 6-inch plaster rollers should be used, and the plaster carefully and snugly molded over the knee and foot to insure complete immobilization of the limb. While this method of treatment is the ideal one, and undoubtedly fulfils the indications better than any other, in a fair number of instances in old, feeble, or very obese individuals, its employment would be impracticable, and in these the use of a modified Buck's extension apparatus is to be advised (Fig. 340). Place the patient on a narrow bed with a hard mattress well

Fig. 338.



Whitman's method of reducing deformity by traction and abduction.

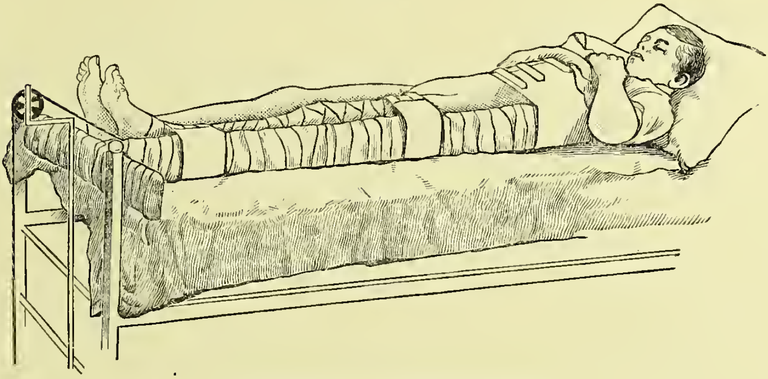
Fig. 339.



The long spica as applied for the treatment of fracture of the neck of the femur in the adult at an angle of abduction of 45 degrees.

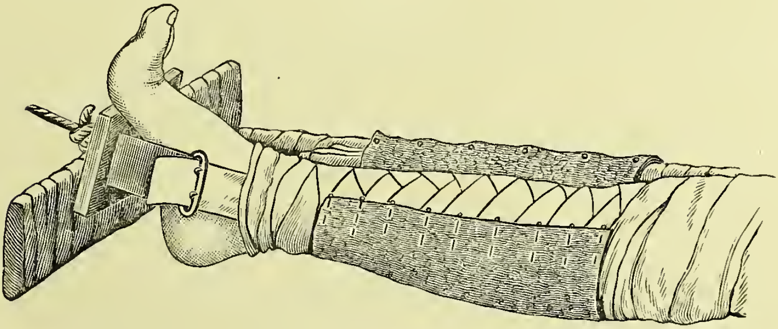
supported so as to present a level surface. Traction straps of adhesive plaster are placed well above the knee on each side of the leg and attached to a foot-board below, from the centre of which a heavy weight cord runs over a pulley fastened to the foot of the bed. The traction straps are held in place by a bandage, care being taken to protect the malleoli. A long T side-splint is placed along the body and leg, from the axilla to a point six or eight inches below the foot. This is well padded and held in place by a body-binder and several straps. The heel is supported on a small ring made of raw cotton and a bandage. Eversion is corrected by pinning a strip of canton flannel along the inner side of the leg bandage, passing it under the leg and over the side-splint, where it is secured by several tacks. This suspends the leg, taking pressure from the heel, and causes the required inversion (Fig. 341).

Fig. 340.



Modified Buck's extension apparatus.

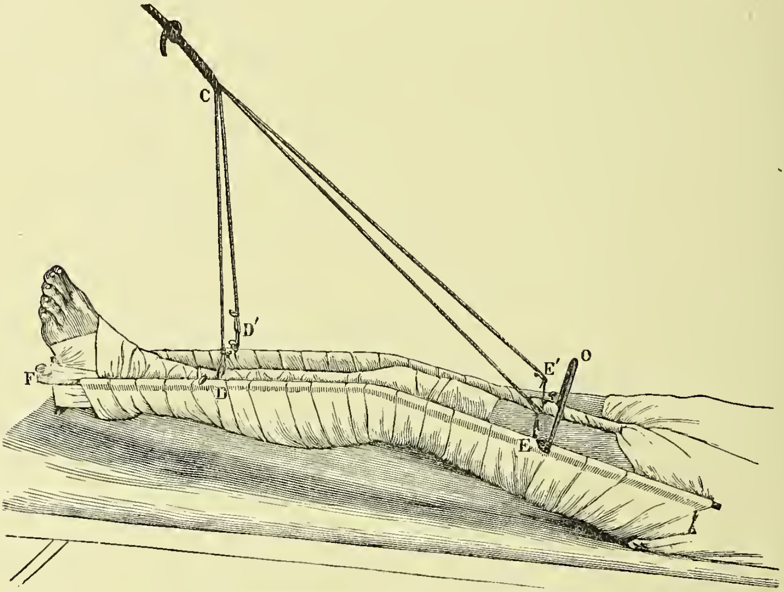
Fig. 341.



Appliance to overcome eversion.

Another method of treatment is by the use of Hodgen's suspended splint (Fig. 342), in which the leg rests in a muslin or canvas gutter supported by two iron bars attached above by a curved cross-piece fitting the thigh and below by a straight connecting rod. By this apparatus the leg is raised from the bed by a traction pulley, and any degree of extension or elevation can be obtained by changing the direction of the traction apparatus. To avoid the evil results of confinement in bed, Phelps and others have suggested the plan of treating these cases by a fixation apparatus made of a metal bar and numerous supporting straps similar to the hip-splints used in the treatment of tuberculous arthritis of that joint (Fig. 343). The treatment of this fracture in infants and young children should invariably be by the abduction method. In these cases union is generally prompt and the functional result perfect. In epiphyseal separations, if accurate reposition of the fragments cannot be effected by manipulation and demonstrated by the x-rays, open operation should be performed and the fragments accurately replaced and sutured.

Fig. 342.



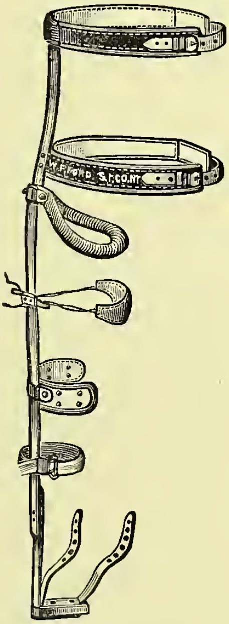
Hodgen's suspended splint. (Stimson.)

In cases of non-union in adults, operative intervention is to be considered when the general health of the individual is such as would warrant a moderately severe operative procedure, followed by confinement in bed for several weeks. Two methods of treatment are to be advised: First, accurate readjustment of the fragment and fixation by nails or bone pegs; and second, the production of firm, bony anchylosis between the femur and pelvis.

The first procedure is indicated when the upper fragment is viable and of sufficient size to be held by a nail or peg; the second, when the blood supply to the upper fragment has been destroyed.

The incision which best exposes the femoral neck is the one advised by Flint, and is as follows: The knife is entered 1½ inches behind the anterior superior spinous process and carried downward and backward to the posterior margin of the trochanter, then directly downward for about 5 or 6 inches. The posterior border of the tensor vaginæ femoris is next liberated and the fascia so divided as to allow ample retraction of the anterior musculocutaneous flap. This exposes a triangular area bounded by the rectus, gluti and vastus externus, at the bottom of which the femoral neck is found. The capsule is next divided and the condition of the upper fragment determined. If it is viable, the fractured surfaces are freshened by gentle curettage, and the two fragments fastened together by a nail driven through the trochanter neck and head or, better, by a bone peg after boring a hole through these structures by a bone drill. The length of the bone peg should be from 3½ to 4 inches in an adult. If the upper fragment is dead, it should be removed, the cavity of the acetabulum curetted, the ilium just above the acetabulum denuded and roughened, the distal neck fragment placed in the cavity, and retained by suture of the soft parts or by means of a bone or ivory peg. If there is no neck fragment, the top of the trochanter is removed and the denuded upper part of the shaft placed in the acetabulum, after which the trochanteric fragment is sutured to the junction of the femur with the upper rim of the acetabulum, the leg placed in a position of abduction, the wound closed, and a plaster spica applied.[1]

Fig. 343.



Phelps' hip-splint.

Fractures of the Shaft of the Femur.—These are divided into fractures of the upper, middle, and lower thirds of the bone. They may be caused by direct or indirect violence, or by muscular action, or by a combination of these agencies. They are rarely compound, and although often accompanied by severe contusion and swelling of the soft parts, injury to the nerve-trunks and great vessels is rare. In fractures of the *upper third* of the shaft, the line of fracture may be transverse or oblique, the upper fragment is generally displaced upward and outward by the action of the ilio-psoas, and the lower one slightly inward by the adductors. This may also occur in fractures of the *middle third*, but in most cases in this region the displacement of the fragments is influenced rather by the direction of the fracturing force than the action of muscles, although the powerful muscles almost invariably act to produce a considerable shortening. In children the direction of the line of fracture in the middle third is generally transverse; in adults it may be either transverse, oblique, or spiral. In fracture of the lower third the lower fragment is apt to be drawn downward by the action of the gastrocnemius muscle.

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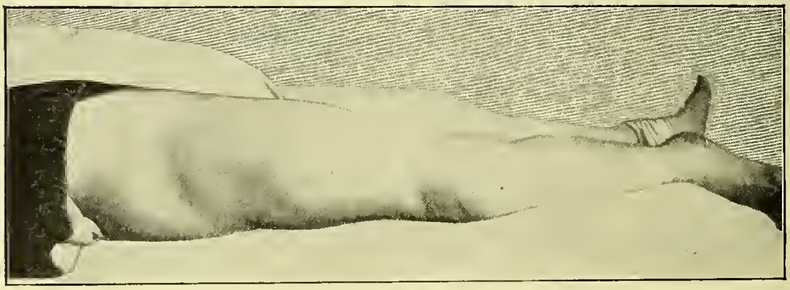
[1] For a fuller description of these procedures, see article by Flint, "Annals of Surgery," October, 1908.

Diagnosis.—In healthy adults there is a history of some severe trauma, followed by acute pain in the thigh and total inability to use the limb. Not infrequently the patient is conscious of a distinct sound caused by the breaking bone. On inspection, the limb is shortened and the thigh abnormally curved. There may be eversion or inversion of the foot. On palpation, localized pain, mobility, and crepitus are easily obtained. Contraction of the psoas muscle is apt to occur from the handling, or during the administration of the anæsthetic, causing marked increase in the deformity. In fractures high up (subtrochanteric) there is a prominence a few inches below Poupart's ligament, caused by the small upper fragment being tilted upward and outward. In fractures low down (supracondyloid) there is a bony prominence felt in the upper part of the poplitcal space from the action of the gastrocnemius on the lower fragment (Fig. 344).

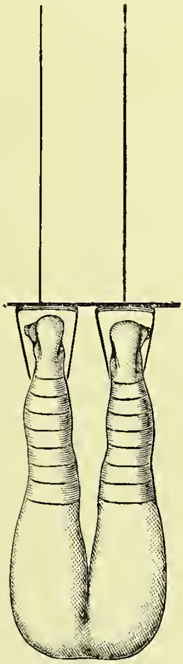
Fig. 344.



Fracture of the shaft of the femur. (Stimson.)

Prognosis.—While simple uncomplicated fractures of the femur usually unite in from six to eight weeks, it should be remembered that in the aged this confinement may be a source of danger. The possibility of paralysis from nerve injury, although remote, should be borne in mind. A certain amount of shortening of the limb commonly follows this fracture, due, in the majority of instances, to overriding of the fragments. This overriding may result in delayed union. Non-union is rare, but may occur, as in the humerus, by the interposition of muscular or fascial bands between the fractured ends of the bone. In a fair proportion of cases effusion into the knee-joint follows fracture of the femur, and may persist for months after the patient is up and about, giving rise to pain, stiffness, and more or less complete anchylosis. In compound fractures of the femur the danger to life is great. Infection once introduced into such a wound is with difficulty controlled; prolonged suppuration, osteomyelitis, and general sepsis usually result.

FIG. 345.



Vertical suspension in children. (Stimson).

Treatment.—In the great majority of instances fractures of the shaft of the femur are treated best by Buck's extension apparatus, as described on page 757, with the addition of four or five narrow coaptation splints firmly strapped about the thigh. The weight should be sufficient to overcome the resistance of the muscles and to bring about full extension. In strong adults from fifteen to twenty pounds are necessary at first; later this may be reduced to eight or ten pounds. In fractures of the upper third the tendency to displacement of the upper fragment should be met with some apparatus which allows flexion at the hip and slight abduction. Hodgen's suspended splint or the double-inclined plane will be found to meet this indication in the majority of instances. In supracondyloid fractures the deformity caused by the tilting downward of the upper extremity of the lower fragment must be overcome by flexion of the knee, or, as suggested by Scudder, by tenotomy of the Achilles tendon. The double-inclined plane splint is to be employed in these cases.

In children, fractures in the upper third are treated best by vertical suspension of both legs (Fig. 345); in all other portions of the bone by the use of plaster-of-Paris spica from the waist-line to the ankle, applied during full extension under anæsthesia.

Compound fractures of the femur should be freely exposed as soon as possible after the injury, all blood-clots and lacerated tissues removed, the bone reduced and held in position by a chromicized catgut suture, the wound thoroughly cleansed and partly united with generous drainage. A plaster-of-Paris spica with windows for drainage and dressings will be found to be the most convenient form of retention apparatus. Early amputation should be resorted to if the signs of general sepsis are progressive.

Fractures of the Lower Extremity of the Femur.—These are epiphyseal separations, fractures of either condyle, and the T-fracture into the joint.

Separations of the lower epiphysis, which may occur before the twenty-first year, generally much earlier, are not so very uncommon. They result generally from severe violence, often accompanied by rotary motion of the limb.

The **symptoms** are similar to those of a supracondyloid fracture, the difference being that in the epiphyseal separation the crepitus is soft and cartilaginous rather than bony.

Treatment.—Reduction is often difficult, and may require open operation. When reduction has been accomplished, the injury may be treated on a double-inclined plane or by a plaster-of-Paris cast.

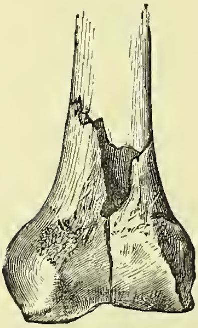
Fracture of either condyle may occur as the result of direct violence or some severe lateral strain at the knee.

The **symptoms** are pain, mobility, and crepitus in the region of the injured condyle, with effusion into the joint. The fragment is generally displaced upward; there is a large range of lateral movement at the knee.

Treatment.—If the fragment is easily reduced, the fracture may be treated by a posterior splint, with cold applications to the knee until the swelling begins to diminish. After that a plaster-of-Paris cast may be applied or Hodgen's splint used. If reduction is difficult or if there is a strong tendency to a reproduction of the deformity, open operation is to be advised, if the conditions are such as to insure perfect asepsis.

T-fracture into the Joint (Fig. 346).—A fracture above and between the condyles, the line of separation of the two condyles passing through the intercondyloid notch; generally due to some severe violence, and is not infrequently compound.

FIG. 346.



Intercondyloid fracture of the femur. (Bryant.)

Symptoms.—When simple, the injury is recognized by the evidences of a supracondyloid fracture plus separate mobility of the condyles and an effusion into the joint. There is also an increase in the distance between the condyles, which is often obscured by the joint-effusion. Not infrequently the fracture is comminuted. Union under these conditions is almost always accompanied by irregularities of the articular surface, giving rise to imperfect motion in the joint or anchylosis.

As in all fractures involving a joint, the **prognosis** should be guarded regarding the functional result.

In the **treatment** of these fractures one should bear in mind the possibility of anchylosis, and remember that in this condition the best position of the limb is one of very slight flexion. This position can best be maintained by a plaster-of-Paris cast. If there are much swelling and joint-effusion, a well-padded posterior splint should be employed at first, with an ice-bag or wet dressings to the knee.

Operative Treatment of Fractures of the Femur.—The operative treatment of fractures of the shaft of the femur is being advocated by some surgeons as a routine practice. The reasons advanced are that, in the great majority of cases treated by conservative methods, the bony fragments are not accurately replaced, and more or less overriding is the rule. This always results in shortening of the limb and imperfect function, and, in not a few instances, in deformity and non-union.

The results of operative treatment, when successful, are undoubtedly far better than by non-operative method, but it must be borne in mind that operation in these cases always carries with it a small risk of infection, which not infrequently results in greatly delayed union and chronic osteomyelitis. The operation, therefore, should only be undertaken when the surgeon can command well-trained assistants and conditions of perfect asepsis.

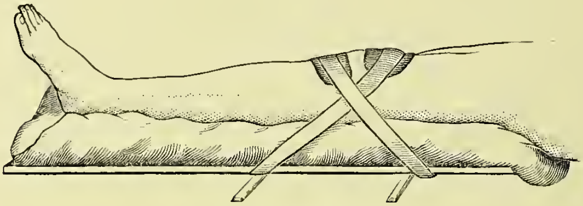
The author advises operation in all cases of fracture of the shaft of the femur where the fragments are separated by the soft tissues, as evidenced by the inability to obtain crepitus under general anasthesia; in cases of fracture in the upper or lower third of the bone, when angulation of the fragments cannot be overcome by position and traction; and in all comminuted fractures of the lower extremity, where the function of the knee joint is likely to be seriously compromised. At least five days should elapse after the injury before open operation is undertaken.

Fractures of the Patella.

The patella may be broken by a direct blow or fall upon the bone, which generally produces a longitudinal, irregular, or comminuted fracture; or more commonly by muscular action, a violent contraction of the quadriceps extensor, the knee being partly flexed, which produces a transverse fracture or one which is slightly oblique. It is probable that a combination of both of these agencies may be present in certain cases. In the more commonly observed fractures by muscular action the line of separation is generally situated below the middle of the bone, and is usually accompanied by lateral tears in the aponeurosis of the quadriceps muscle. The upper fragment is drawn upward by the contraction of the muscle, and this separation is increased still further by hemorrhage and an effusion of synovial fluid in the joint.

Diagnosis.—There is a history of a fall, with sudden pain in the knee and inability to use the limb. Occasionally the patient is able to stand, but any attempt to walk will generally be accompanied by involuntary sudden flexion at the knee, which causes him to fall again. On examination, the region of the joint is found swollen, tender to the touch, and painful on motion; the synovial cavity is distended and the normal outlines are obliterated; the power of extension and the ability to raise the heel from the bed are lost. Palpation reveals the presence of two or more fragments, with a varying degree of separation if the fracture is transverse; crepitus is rarely obtained in transverse fractures unless the separation is slight and easily overcome.

Fig. 347.



Plaster straps applied.

Treatment.—The conservative, or non-operative treatment of fracture of the patella consists in absolute rest in bed, the application of a ham-splint, and the use of an ice-bag or evaporating lotions to the joint until the effusion and evidences of inflammation have subsided. An effort should be made to draw the fragments together by means of adhesive straps (Fig. 347), and to relax the quadriceps tendon by flexion at the hip, although the value of the latter procedure is questionable. The adhesive straps should be frequently inspected and changed as often as they become loosened. At the end of three weeks the leg may be encased in a light plaster cast and the patient allowed up on crutches. This cast should be worn for six weeks more, after which a heavy elastic knee-cap or some form of metal brace should be worn for at least six months to prevent excessive movement at the knee. Massage and passive motion should be undertaken as soon as there is evidence of good ligamentous union of the fragments.

The operative treatment of fracture of the patella should be undertaken only by an experienced surgeon with trained assistants, under conditions of absolutely perfect aseptic technic. The following method is the one at present employed at the Roosevelt Hospital: Preparation of the leg is commenced forty-eight hours before the operation, by shaving and scrubbing the part with green soap and hot water. A soap poultice is next applied and allowed to remain in place over night. The following morning the leg is again scrubbed for ten minutes with soap and hot water, after which it is douched with ether, alcohol, and bichloride solution. A wet dressing of mercuric chloride (1 : 5000) is then applied and allowed to remain in place until the patient is anæsthetized. On the operating-table the dressings are removed and the leg again scrubbed for one minute by an assistant after thorough cleansing of the hands, after which it is wiped with gauze sponges wet with ether, alcohol, and an alcoholic solution of bichloride (1 : 2000), and finally douched with sterile water. A transverse or vertical incision is then made exposing the whole of the patella; the clots and fragments of torn periosteum or aponeurosis lying between the fragments are removed, and the joint-cavity thoroughly irrigated with sterile salt solution. If the fragments are easily approximated, they are held in place by suturing the periosteum and torn aponeurosis with chromicized catgut. If this is not sufficient to insure accurate coaptation, the bone is firmly joined by two sutures of heavy chromicized catgut passed through openings drilled obliquely through the fragments, avoiding the articular surfaces. The cutaneous incision is then united with silk-worm gut sutures, and the superficial wound drained by two small rubber tissue drains inserted at either extremity of the wound. Aseptic dressings are then applied and the limb encased in a plaster-of-Paris cast. Complete healing of the wound should take place under the primary dressing, which may be left in place from one to three weeks if there is no evidence of infection.

Prognosis.—Bony union is not to be expected in cases treated by the conservative method. When the original separation is slight, the ligamentous union may be close, firm, and the functional result perfect. Generally, however, the fragments are separated by an interval of from one-half to two inches, and this separation may be increased as the use of the leg is resumed. In many cases, however, even when the separation of the fragments is considerable, the resulting disability is slight, and practically no inconvenience is experienced by the patient. Occasionally the disability is great, necessitating a change in the habits or occupation of the individual. The results of skilful operative treatment, when no infection occurs, are practically perfect, firm bony or close ligamentous union being the rule, with perfect restoration of function.

The occurrence of septic infection of the knee-joint following open operation is of the greatest prognostic importance, for it generally results in complete and permanent anchylosis of the joint, loss of the limb or the life of the individual. As these results outweigh in their seriousness any disability likely to follow conservative treatment, the operative treatment should only be employed under the conditions enumerated above, and after a frank statement of the risks to the patient or his friends. Flint, from an analysis of 150 cases of open operation in fractures of the patella, has demonstrated that the dangers of sepsis are greatest during the first five days after the injury, and that the safest time to operate is between the fifth and tenth day.

Fractures of the Lower Leg.

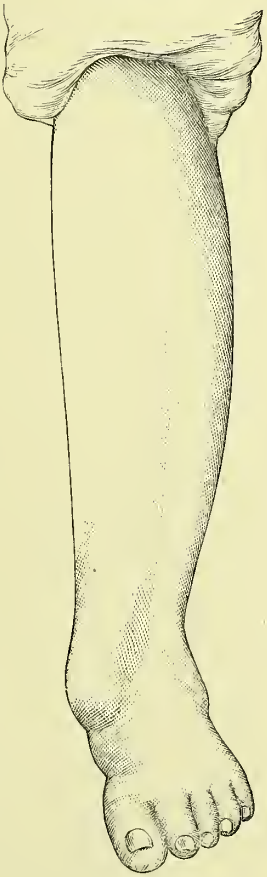
These fractures are common in middle life, and especially in men. They are the result of direct or indirect violence, and are frequently compound.

Fractures of both Bones.—When due to indirect violence, fracture of the tibia usually occurs at about the juncture of the middle and lower thirds, that of the fibula slightly above this point ; when due to direct violence, the fracture may occur at any point, and is often comminuted. The line of fracture in the tibia is of considerable importance in regard to prognosis and treatment. It is commonly transverse, but, as in other long bones, it may be oblique or irregular. In oblique fractures the direction is generally from behind and above downward, forward and somewhat inward, making the sharp angle of the upper fragment appear immediately beneath the skin. The lower fragment is usually displaced upward by the muscles of the calf, and when this displacement is marked the sharp upper fragment often pierces the skin, rendering the fracture compound. Spiral fractures due to forcible rotation of the foot, the body being fixed, are occasionally seen, and present serious difficulties in their treatment.

Fracture of the Tibia Alone.—Fractures of the upper extremity of the tibia are comparatively rare; they may be transverse or oblique, extending into the joint. Separation of the upper epiphysis has been occasionally reported. The fractures occurring in the shaft are more common, and similar to those observed when both bones are broken. There is, however, very little deformity, owing to the splint-like action of the unbroken fibula. Fractures of the lower extremity alone are rare, although a number of instances of separation of the lower epiphysis have been reported.

Fractures of the fibula alone are exceedingly common if we include in this class Pott's fracture, in which the internal lateral ligament of the ankle or the tip of the internal malleolus is ruptured. The fibula may be broken in any part of its shaft by direct violence. When the injury is due to indirect violence, as by forcible inversion or eversion of the foot, the fracture always occurs in the lower third, from one to four inches above the malleolus. Displacement in these fractures is not marked, except in the case of Pott's fracture, in which the deformity is very characteristic. In this fracture, which is caused by violent eversion of the foot, alone or combined with external rotation, there is first a rupture of the internal lateral ligament or a fracture of the internal malleolus; this allows an outward dislocation at the ankle, which causes next a tearing apart of the tibiofibular attachment, and finally a fracture of the fibula just above the joint by forcible bending outward of the external malleolus. The fracture of the fibula is generally transverse, both fragments forming an angle the apex of which is directed inward against the tibia. If rotation played an important part in the injury, the fibular fracture may be oblique, extending well up the shaft. The force causing this injury may cease at any point and occasionally the fibula is not broken, or it may be continued, causing a compound outward dislocation of the ankle. In certain rare cases there is a marked backward displacement of the foot at the tibiotarsal joint.

Fig. 348.



Pott's fracture: outward displacement. (Stimson.)

Diagnosis.—Both legs should first be inspected. Shortening, angular deformity, and irregularity in outline suggest a fracture of both bones; eversion and prominence of the internal malleolus, Pott's fracture (Fig. 348); abduction or adduction of the knee, a fracture of the head of the tibia. The subcutaneous surface of the tibia should next be palpated from the knee to the ankle. This may reveal irregularities in outline and points of tenderness. The region of the fibula should then be palpated. This in the lower third is easy, but above that point more difficult, owing to the muscular coverings. The leg should then be placed across the knee of the surgeon, and abnormal mobility sought for at the knee, ankle, or along the shafts of the bones. Crepitus is often elicited by motion at the knee or ankle or by pressure on one or both bones in the neighborhood of any point of suspicious tenderness.

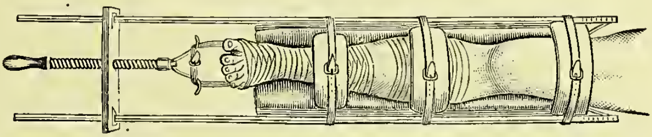
While the presence of marked deformity, abnormal mobility, and crepitus will always serve to establish the diagnosis of fracture, fractures not infrequently occur without these signs. This is particularly true in fractures of the fibula near the ankle, where often the only signs are a limited point of tenderness and pain on motion. An examination by the x-rays is often of the greatest value, not only in determining the presence of fracture in these doubtful cases, but also to reveal the direction of the fracture, number of fragments, and character of displacement, in cases accompanied by considerable swelling.

Prognosis.—In compound fractures of the leg, especially if the bones are comminuted and the soft parts extensively injured, the prognosis is exceedingly grave. Simple fractures, especially the oblique variety, not infrequently become compound by carelessness in handling and in transportation. In simple fractures of one or both bones the prognosis is generally favorable if reduction is perfect and can be maintained. Difficulty in permanent fixation of the fragments in oblique fractures of the tibia is often encountered, and results in delayed union and shortening. Improperly treated Pott's fracture is almost sure to result in a weak ankle with eversion and flat foot.

Treatment.—Fractures of the upper extremity of the tibia involving the joint should be treated at first by a fracture-box or side-splints, with an ice-bag or cooling lotions to the joint; later, by a plaster cast in the extended or slightly flexed position. In transverse fractures of the shafts of the tibia and fibula, or of either bone alone, when there is little or no trauma of the soft parts, and when reduction can be effected, the immediate application of a plaster-of-Paris cast or the plaster posterior splint is to be recommended. In fractures by direct violence when there is extensive contusion of the soft parts the leg should be placed in a fracture-box or supported by side-splints, and a wet dressing of aluminium acetate solution should be applied until the swelling subsides, after which a plaster-of-Paris splint should be employed.

Oblique fractures of the tibia with fracture of the fibula, when the tendency to overriding is marked, should be treated by the immediate application of a plaster cast, when the condition of the soft parts will permit, full extension being maintained until the plaster hardens. In these fractures, which are often exceedingly difficult to reduce accurately, and which often become displaced during the application of the plaster cast, great help is afforded by the use of the fluoroscope during the application of the dressing. It not infrequently happens that owing to the condition of the soft parts these oblique fractures cannot be treated by a plaster cast for several weeks after receipt of the injury. In these cases it is desirable to maintain some degree of extension to prevent union with deformity. The short Desault splint will be found useful under these circumstances (Fig. 349). In certain cases of oblique fracture, with considerable overriding and deformity, open operation is to be advised.

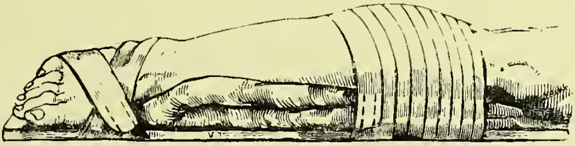
Fig. 349.



Continuous traction in fracture of the leg. (Stimson.)

In the treatment of *Pott's fracture*, in order to insure close union of the broken internal malleolus, or of the torn ligament, as well as complete reduction of the angular deformity in the broken fibula, the foot should be placed in a position of marked inversion.

Fig. 350.



Dupuytren's splint. (Gross.)

The use of the Dupuytren splint (Fig. 350) is to be recommended until the swelling subsides, and later the application of a plaster cast, which maintains the foot in a position of strong inversion.

Vicious union following Pott's fracture results in marked deformity and functional disability. For this condition Stimson advises the following operation: Incision along the anterior border of the fibula, through which the line of fracture is recognized and the fragments separated; second incision along inner side of tibia, downward in front of inner malleolus as far as the tubercle of the scaphoid. The malleolar fragment, if united, is separated with a chisel and mallet, the joint opened, and the lower end of the tibia protruded, the astragalus liberated from adhesions and replaced, the incisions closed and the parts surrounded by a sterile dressing, and held in an overcorrected position by a plaster cast.

Compound fractures should be treated by free incisions, removal of blood-clots loose fragments of bone and torn muscle, thorough disinfection with hydrogen peroxide or formalin solution (1 : 50), and prolonged irrigation with bichloride solution (1 : 1000); after which the bones should be approximated and held, if necessary, by chromicized catgut sutures, and the wound partly closed with generous drainage. The employment of a plaster-of-Paris cast, with windows over the region of the wound and drainage openings, is of the greatest value in the treatment of these fractures, saving the patient much pain and discomfort during the earlier dressings. If no infection occurs, the primary dressings should be left in place for two or more weeks. In the presence of a progressive infection not controlled by local measures, amputation should be resorted to at an early period to save life.

Fractures of the Bones of the Foot.

Fractures of the bones of the foot are of fairly frequent occurrence, are often accompanied by wounds of the soft parts, and are generally due to direct violence.

Fractures of the calcaneum may be produced by a fall upon the feet from a height or by muscular action in falling upon the ball of the foot. In the first variety the fracture occurs generally in the middle or anterior portion of the bone and is often comminuted. In cases caused by muscular action the fracture is apt to be limited to the posterior portion of the bone, and often to the point of attachment of the Achilles tendon.

Fractures of the astragalus are caused by falls upon the feet, the bone being crushed between the tibia and calcaneum, or by forced flexion of the foot. In the former instance the fracture occurs in the body of the bone and may be comminuted. In the latter the fracture is generally limited to the neck.

Fractures of the other tarsal bones are very rare. Those of the metatarsals and phalanges are more common, and, as in the case of the bones of the hand, are frequently compound.

The **diagnosis** is often difficult. Fractures of the *calcaneum* can generally be recognized by local tenderness, mobility, and crepitus. If limited to the posterior portion of the bone, the fragment attached to the tendo Achillis is generally drawn upward. Fractures of the *astragalus* may be assumed if there is localized pain on motion of the foot, crepitus, and inability to stand, and if fracture of the other neighboring bones can be excluded. In both the foot is flattened, the heel thickened, the malleoli nearer the ground, and the normal outlines obliterated. Fractures of the *metatarsal* *bones* and *phalanges* can generally be recognized by palpation. In these fractures an *x*-ray examination is often necessary to arrive at a correct diagnosis; in fact, in all injuries about the ankle the *x*-rays should be employed as a routine practice.

Regarding prognosis in fractures of the tarsal bones, it may be said that the result of treatment is generally unsatisfactory. Ely[1] has shown that a large percentage of the cases have more or less permanent disability. The causes of the disability are limitation of motion and persistent pain in walking. One of the most frequent sources of pain is the presence of a fragment of projecting bone or exostosis in the soft tissues of the heel; another is the formation of a mass of callus beneath and about the tip of the external malleolus, to which attention has recently been called by Cabot and Binney.[2]

Treatment.—In the treatment of fractures of the bones of the foot it is most important to restore the fragments to their normal positions and hold them securely until union has taken place, for it is only in this way that the normal arches can be maintained.

In fractures of the posterior portion of the calcaneum, the knee should be flexed and ankle extended to allow the separated fragments to become approximated. In fractures of the body of the calcaneum and of the astragalus an effort should be made to break up any impaction which may be present and restore the normal outlines of the bone and shape of the ankle. This is often greatly facilitated by the use of the fluoroscope, which allows the surgeon constantly to compare the injured with the normal ankle. The best position for all fractures of the tarsal bones, with the exception of those of the posterior portion of the calcaneum, is in strong dorsal flexion and inversion. Where the fragments cannot be satisfactorily readjusted by manipulation, open operation is to be advised. In fractures of the posterior portion of the calcaneum with marked separation of the fragments by upward traction of the Achilles tendon, division of this tendon or uniting the fragments by chromic suture or nails will insure practically a perfect result. In fractures of the body of the calcaneum the fragments can generally be readjusted best by a plantar incision. Astragalectomy is often indicated for late disability. The removal of a projecting exostosis on the heel will often relieve a persistent pain in walking. Massage and passive movements are useful in recent cases, and should be regularly employed after the third week.

The treatment of fracture of the metatarsal bones and phalanges should be by rest and molded gutta-percha splints. Wet dressings for the first few days after the injury are often necessary to subdue inflammation of the soft parts and joint-membranes.

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[1] "Annals of Surgery," January, 1907.

[2] "Annals of Surgery," January, 1907.

CHAPTER XXVIII.

DISLOCATIONS.

The term *dislocation* in its surgical sense refers to a separation of the articular surfaces of two or more bones entering into the formation of a joint.

This separation is generally the result of injury, and such dislocations are called *traumatic* dislocations: it is occasionally brought about by disease, resulting in the destruction of some or all of the tissues of the joint, after which the bone is displaced by muscular action; these dislocations are spoken of as *pathologic* or *spontaneous* dislocations: or it may be rarely the result of some prenatal defect or malformation, in which case it is characterized as a *congenital* dislocation.

A dislocation is said to be *complete* when the articular surfaces are entirely separated from each other; *incomplete*, when they remain at some point in contact. As in the case of fractures, dislocations may be *simple* or *compound;* the former when the lesion is covered by unbroken skin, the latter when the soft parts are lacerated, creating an external wound leading to the joint-cavity. A *complicated* dislocation is one in which the trauma results in additional neighboring injury, as a fracture of one of the bones forming the joint, or injury to adjacent vessels or nerve-trunks.

The terms *double, multiple,* and *symmetric* are sometimes employed to describe dislocations when the injury results in more than one luxation.

In the classification of dislocations the nomenclature follows no definite system. In some instances the name of the joint is used to describe the dislocation, as dislocation at the hip, shoulder, elbow; in other instances the distal bone is named, as dislocation of the head of the radius or a phalanx or metacarpal bone; in others the proximal bone is named, as dislocation of the acromial end of the clavicle or of the lower extremity of the ulna. In describing the direction of a dislocation, the terms anterior, posterior, external, and internal are employed at the knee, elbow, and a number of other joints; in other instances anatomic regions are used, as dorsal, pubic, sciatic, thyroid at the hip, subglenoid, subcoracoid, etc., at the shoulder.

The term *fracture-dislocation* is used in injuries of the spinal column, when both fracture and dislocation of one or more of the vertebral segments have occurred.

Causation.—The conditions which favor dislocations, and which therefore may be regarded as predisposing factors, are: the male sex, on account of greater exposure to injury; adult life, on account of the diminished liability to fracture; injury to certain joints, on account of their large range of motion and the absence of supporting ligaments, as the shoulder, which furnishes nearly one-half of all dislocations, or other joints, from their situation being more exposed to trauma, as the elbow- and finger-joints. Previous injury or disease may predispose a joint to dislocation by causing relaxation of the supporting capsule, ligaments, or muscles. The exciting causes of dislocation are direct or indirect violence and muscular action. As an example of direct injury causing dislocation, may be mentioned a fall upon the back from a height, giving rise to a dislocation of the spinal column; indirect violence acts by a force received on one extremity of a long bone being transmitted to a joint situated at a distance, as a fall on the hand or elbow causing a dislocation at the shoulder. The shoulder has been dislocated by violent muscular action alone, as in throwing a ball or stone. Muscular action, however, is more frequently a contributing cause, acting with direct or indirect violence.

Pathologic Anatomy.—Under certain conditions of disease, as when a joint-capsule has been greatly relaxed by distention with fluid or the normal support of muscular structures has been removed by paralysis, incomplete and even complete dislocation may occur without rupture of any of the peri-articular soft tissues. Under normal conditions, however, when a dislocation occurs there is more or less laceration of the synovial membrane, capsule, ligaments, and adjacent muscular structures. In the ball-and-socket joints there is a rent in the capsule through which the head of the bone protrudes; in the hinge-joints the various ligaments are extensively damaged, and not infrequently the bony attachments of the ligaments are separated. Hemorrhage is always present from the torn tissues, and may be sufficient to form a distinct hæmatoma. Following the injury there is considerable inflammatory reaction, and in unreduced dislocations the resulting exudate becomes organized and is converted into dense connective tissue, which often renders subsequent efforts at reduction ineffectual.

This formation of dense fibrous tissue will often surround the head of a dislocated bone, eventually forming a new socket, which may later become lined with a kind of synovial membrane allowing considerable motion.

Diagnosis of Dislocations in General.—The symptoms commonly present in traumatic dislocation are pain, severe at the time of injury, continuing moderately while the luxation remains unreduced, but markedly increased by any motion of the part;

deformity which is generally apparent on inspection ; shortening or lengthening of the limb, according to the direction of the displacement, but without change in the length of the bone ; obliteration of the normal outlines of the joint ; abnormal relation of the bony prominences ; restricted motion of the limb ; change in the axis of the displaced bone ; absence of the head of a bone from its socket, or its presence in an abnormal position ; absence of a tendency to redisplacement after reduction. The differential diagnosis between a dislocation and a fracture near a joint is often difficult. In general the symptoms which suggest dislocation are restricted motion, absence of crepitus, and the fact that the deformity is not reproduced after reduction. Those which suggest fracture are abnormal mobility, bony crepitus, and the tendency to recurrence of the deformity after reduction unless the parts are securely held. The symptoms common to both injuries are pain, deformity, obliteration of the normal outlines of the joint, and a change in the axis of the bone.

It should always be remembered that both fracture and dislocation may and frequently do exist in the same case. In spontaneous dislocations there is a history of previous paralysis or joint-disease, and in congenital luxations the deformity is present from birth. In all doubtful cases the examination should be conducted under general anæsthesia and controlled by a fluoroscopic examination or radiograph.

Treatment.—Three methods are employed in the treatment of recent dislocations. These are reduction by manipulation, by extension, and by open operation. Reduction by manipulation consists in executing certain movements of the limb by which the displaced extremity of the bone is made to reach its socket by the same route taken in its exit ; the method is chiefly applicable to the shoulder and hip. The method by extension consists in the employment of manual traction on the limb with firm counter-extension by an assistant. The first effect of this is to relax the firmly contracted muscles, after which the bone often slips back into position or may be easily replaced by manipulation. Formerly, when more force was required than could be brought to bear on the part by manual traction, compound pulleys were employed, but today open operation is generally preferred to the use of great force. Reduction by open operation should be resorted to when other methods fail. It should, however, never be undertaken unless the conditions are such as to insure a thoroughly aseptic operation. Under favorable conditions the joint can be freely exposed by incision, any bands of muscle or fascia preventing reduction divided or displaced, the bone replaced, the joint-cavity thoroughly irrigated, the capsule and soft parts united, and an immovable dressing applied. The question of drainage should be settled by the operator at the time of operation, when the condition of the part is known and the perfection of technic appreciated.

In *old dislocations* the obstacles to reduction and restoration of function consist in firm fibrous adhesions holding the displaced bone in its abnormal position; filling up of the socket by fibrous material, which would prevent complete reduction; and changes in the articular surfaces, as erosion or disappearance of the cartilage, which, if reduction could be accomplished, would prevent free motion in the joint. The question of attempting reduction in these cases should always be decided by the patient after a candid statement of the probabilities of improvement and the risks of operation. It should not be forgotten, moreover, that a fair functional result will often follow the formation of a false joint, and that late reduction is often followed by complete anchylosis.

Attempts at reduction in these cases by manipulation and extension should not be undertaken after the formation of firm adhesions, as the danger of fracture is great, which, if it should occur, would necessarily diminish the chances of subsequent reduction by any means. The only safe method is by open arthrotomy, removal of the obstructing fibrous material, loosening of the displaced extremity of the bone, and replacement by means of elevators or the McBurney hook. The subsequent steps of the operation are the same as in the case of recent dislocations. Passive motion should be undertaken early; and later, massage, baths, and electricity will serve to restore the function of the surrounding muscles. Excision of the head of the bone, in cases of unreduced dislocation with greatly restricted motion, offers, especially in the shoulder, a fair chance for an improved functional result.

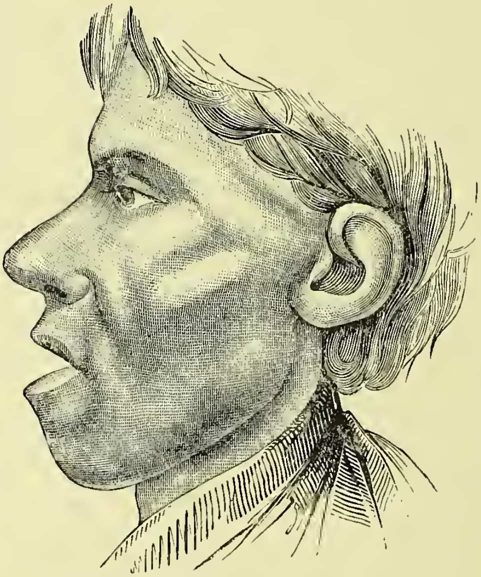
Compound dislocations of the larger joints are justly considered as among the most serious of bodily injuries. They generally outrank in gravity compound fractures, for the reason that a relatively greater degree of force is necessary for their production, and the resulting shock and laceration of neighboring tissues add greatly to their gravity. When the injury to the vessels, nerves, and other soft parts is beyond repair, immediate amputation is to be advised; when there is a possibility of saving the limb, thorough disinfection of the wound, removal of torn or bruised fragments of muscle and fascia, reduction of the dislocation with or without excision, partial closure of the wound with abundant drainage and an immovable dressing, and fixing the limb in a favorable position for anchylosis, are to be recommended. Later, evidences of infection call for prompt revision; and if progressive, amputation should not be delayed. Compound dislocations in the smaller joints present a less serious outlook, and conservative measures may safely be carried out in the majority of instances.

SPECIAL DISLOCATIONS.

Dislocation of the Jaw.

Dislocation of the jaw is of fairly frequent occurrence, and is caused by opening the mouth widely, as in laughing, vomiting, or in dental procedures; occasionally it is produced by a blow on the chin while the jaws are separated. It is generally bilateral, although it may occur on one side only. When the mouth is opened, the condyles of the jaw normally pass forward to the articular eminences; a sudden increase in this movement, with strong contraction of the external pterygoid muscles, results in the condyles slipping over this eminence into the temporal fossa. The interarticular fibrocartilage is generally drawn forward with the condyle.

Fig. 351.



Bilateral dislocation of the lower jaw. (Hamilton.)

Diagnosis.—In bilateral dislocation the mouth is widely open, the lower jaw projecting somewhat forward (Fig. 351), the coronoid process can be felt through the mouth to be displaced forward under the zygoma, and a hollow can be seen in front of the ear. Speech and swallowing are impaired, and salivation is present. If the dislocation has occurred on one side only, there is less deformity and the chin is deviated toward the normal side.

Treatment.—Reduction is generally easy. The surgeon should place his thumbs, protected with towelling or gauze, upon the last molar tooth of each side, and make firm pressure downward until the muscles are relaxed; he should then press the jaw backward and at the same time elevate the symphysis by the disengaged fingers. After reduction it is well to apply a four-tailed bandage to prevent for a few days any excessive movements of the jaw until the torn capsule has united.

Dislocations of the Clavicle.

Dislocations of the clavicle may occur at either end. Dislocations at the sternal end may be forward, backward, or upward; dislocations at the acromial end may be upward or downward. Of these, the dislocation forward of the sternal extremity, and upward of the acromial extremity, are the commonest. All other varieties are rare.

Dislocations of the Sternal End.—These are produced generally by some force applied to the tip of the shoulder forcing it violently backward, forward, or downward, which drives the sternal extremity of the bone from its bed. Direct violence by blows or crushes may give rise to the backward variety.

Diagnosis.—In all cases there is a history of injury, with pain in the region of the sternoclavicular joint and inability to use the arm. In forward dislocation the head of the bone rests in front of the sternum, forming a distinct prominence at the root of the neck; the shoulder is apparently nearer the median line than normal; the sternomastoid muscle is rigid. In backward dislocation there is a depression at the point normally occupied by the head of the bone; the neck is rigid; the shoulder falls inward. There may be congestion of the arm, dyspnœa, or dysphagia from pressure on the venous trunks, trachea, or œsophagus. In the upward variety the dislocated end of the bone can be distinctly felt above the sternum, behind the sternal origin of the sternomastoid muscle.

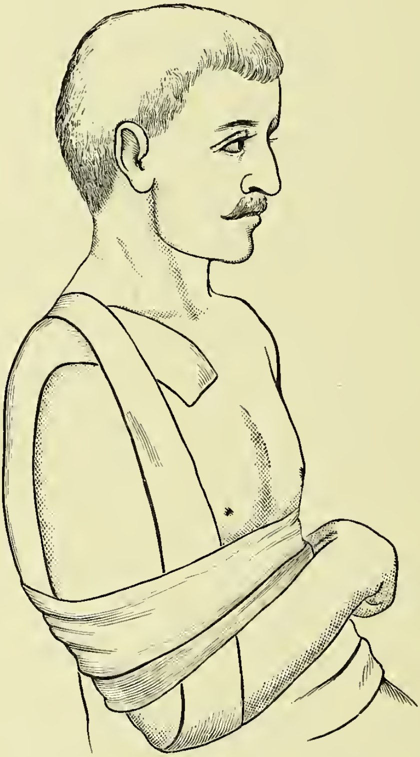
Treatment.—In all these varieties reduction is generally easy, and is effected by placing the knee firmly against the spine between the scapulæ and with both hands drawing the shoulders backward. Direct pressure over the head of the displaced bone will often facilitate reduction.

The classic retention dressing is a figure-of-eight bandage applied posteriorly to the shoulders. Stimson advises holding the shoulder forward by an anterior figure-of-eight or Velpeau bandage.

If the tendency to displacement is marked, and especially if in backward dislocations pressure-symptoms are unrelieved, open operation with suture or excision of the head of the bone is indicated.

Dislocations of the Acromial End.—*Upward dislocations* are generally produced by applications of force to the tip of the shoulder in a downward direction plus vigorous contraction of the trapezius muscle which draws the acromial extremity of the bone upward. In the rare *downward* displacements the force is usually applied from above in a downward direction to the upper surface of the clavicle. The outer extremity of the bone is displaced downward and slightly backward, the acromion often overriding it. Subcoracoid downward dislocations of the acromial extremity of the clavicle have been described, although their existence is doubtful.

Fig. 352.



Dressing for supra-acromial dislocation of the clavicle. (Stimson.)

Diagnosis.—In the common upward luxation the pain at the time of the injury may be slight, and the resulting disability insignificant, but in most instances voluntary motion and pressure over the displaced bone are accompanied by severe pain, and there is inability to raise the arm above the head. The shoulder-tip is depressed, the acromial extremity of the clavicle projects upward and may override the acromion, and unless the swelling is marked its smooth articular facet can be easily recognized by palpation.

In the downward variety, in addition to the localized pain there may be numbness of the arm from pressure on the brachial plexus. The deformity is easily recognized by inspection or palpation. The clavicle is depressed, the acromion is prominent, and its articular facet may often be palpated.

Treatment.—Reduction is easily accomplished in most cases by carrying the shoulder upward and backward, with pressure over the displaced extremity of the bone in the upward variety. In the upward variety retention of the bone in its normal position is often difficult, but is best effected by the use of Moore's figure-of-eight bandage from the elbow to the opposite shoulder, or by Stimson's method, which consists in placing the centre of a long strip of adhesive plaster under the flexed elbow, and carrying the ends upward, one in front and one behind the arm, and crossing them just over the acromioclavicular joint. During its application the elbow should be pushed forcibly upward and the clavicle downward (Fig. 352). In the downward variety, after reduction the arm should be fixed to the side by a sling and chest-binder.

Dislocations of the Spine.

If one examines the spinal column in an articulated skeleton, it will be found that in the cervical region the articular processes look generally upward and downward, and that the slight antero-posterior slope is not sufficient to prevent a separation and sliding forward of the upper vertebra upon the lower if sufficient force is applied. It will also be seen that an acute anterior flexion of the head and neck would tend to separate these articular processes and produce such a sliding forward. In the dorsal and lumbar regions, however, the direction of the articulating surfaces is such that this displacement could not occur without a fracture of the articular processes unless the upper vertebra was drawn vertically upward for a considerable distance, a condition which would practically never result from any ordinary violence. These conditions will serve to explain the fact that dislocations of the spine alone without fracture are exceedingly rare, and are practically limited to the cervical region. The association of dislocation with fracture is of frequent occurrence, however; these injuries, which are spoken of as *fracture-dislocations,* have been described in the section devoted to Fractures of the Spine.

Dislocations of the vertebræ, like fractures, are generally produced by some force which bends the spine beyond its normal limits of motion. This bending may be the result of direct violence, as a blow on the back of the neck, or by the indirect violence of a force applied to a distant point of the vertebral column, as diving into shallow water and striking the head violently against the bottom, causing sudden acute flexion. Muscular action may also play a part in the production of dislocation, as in a sudden violent rotary motion of the head during antero-posterior or lateral flexion.

Several varieties of dislocation occur in the cervical region. In the great majority of instances the upper vertebra is displaced forward on the underlying one. If the articular processes on both sides are separated, the dislocation is spoken of as a *bilateral* dislocation; if on one side only, a *unilateral* dislocation. The former is almost always produced by a violent bending forward of the head and neck; the latter, by extreme lateral flexion alone or combined with rotation. Dislocations backward, unilateral and bilateral, have been recorded, but are very rare. Bilateral dislocation in opposite directions—that is, a displacement of the articular process forward on one side and backward on the other—has also been recorded. In forward bilateral dislocations the ligaments are torn, the intervertebral disk is lacerated, the articular processes of the upper vertebra lie in the intervertebral notches of the lower, the cord is crushed, the surrounding plexus of veins is injured giving rise to hemorrhage into the canal, and the nerves are stretched or crushed as they emerge from the intervertebral foramina. In unilateral dislocation the deformity is less, and the cord may be simply stretched and not crushed; the same is true in the bilateral variety if the dislocation is not complete, as occasionally happens. In these cases the articular surfaces are not entirely separated from each other.

Diagnosis.—As in fractures of the cervical spine, there is a history of a severe injury resulting in exaggerated flexion of the vertebral column, followed generally by complete paraplegia below the point of injury. There is localized pain in the neck, which is increased by any motion of the head. Neuralgic pains and muscular twitchings are occasionally observed over the distribution of one or more of the spinal nerves emerging from the injured intervertebral foramina.

Hyperpyrexia, inequality of the pupils, and localized vascular disturbances, occur in certain cases, due to sympathetic irritation.

In unilateral or incomplete dislocation the cord-injury may be slight, and the resulting symptoms irregular and due simply to traction on the cord and its nerves, or to pressure from bone or hemorrhage. In these cases the motor paralysis is generally more extensive than the sensory; both may be incomplete.

In addition to the symptoms enumerated above, examination will reveal the presence of deformity and rigidity of the neck, with an absence of crepitus. There is irregularity in the line of the transverse and spinous processes. A prominence of the dislocated vertebral body may often be seen or felt at the back of the pharynx; the respiration is embarrassed if the injury is above the origin of the phrenics. Priapism is present in some cases. Cystitis and bedsores are prone to develop soon after the injury, and eventually give rise to septic symptoms.

Prognosis.—This depends entirely upon the amount of injury to the cord. If there is evidence of a complete transverse crushing lesion, death is certain; within a few days if the injury is above the exit of the phrenic nerve; at a later period if below this point. In incomplete dislocations when the injury to the cord is slight or the symptoms due to pressure or hemorrhage, recovery may occur.

Treatment.—In unilateral or incomplete dislocations, and in all other cases in which there is no evidence of a complete transverse lesion of the cord, an attempt at reduction should be made. If the cord is crushed, reduction will accomplish nothing, as restoration of function is impossible. On account of a possible error in estimating the degree of injury to the cord, some surgeons advise that an attempt at reduction be made in every instance. The methods employed to effect reduction in cervical dislocations are of two kinds: by manipulation and by open operation.

The method by *manipulation* consists in the employment of vertical extension, flexion, and rotation. In a case under the observation of the writer, a dislocation high up in the cervical region was readily reduced by simply placing one hand under the patient's chin, the other under the occiput, and exerting steady traction upward, the patient being in the sitting position. The replacement was accompanied by a distinct snap, such as is often observed in the replacement of other dislocated bones. In forward dislocations the surgeon should first employ flexion to disengage the articular processes, then traction upward and extension of the head. In unilateral dislocations lateral flexion toward the healthy side should precede upward traction and rotation. Counterextension is often necessary in carrying out these manipulations, and is favored by placing the patient on an inclined plane. If reduction is not accomplished by these means, the patient should be prepared for *operation*, which is carried out in the following manner: Under general anæsthesia the patient should be placed face downward on an operating-table, the head projecting slightly over the end and firmly held by an assistant, who later will thus be able to execute such movements as are directed by the surgeon. An incision six inches in length is then made in the median line over the spinous process, the edges of the wound are firmly held apart by retractors, and all muscular and aponeurotic structures dissected free from the spines, laminæ, and transverse processes. As soon as this is accomplished and the bleeding arrested, the glistening articular facet of the inferior vertebra can generally be seen, with the displaced articular process of the dislocated vertebra above. The assistant in charge of the head, under the direction of the surgeon, executes the various movements of flexion, upward traction, rotation, etc., necessary to disengage the locked articular processes, after which the surgeon by the use of hooks and elevators can generally succeed in prying or drawing the bone back into place. The wound should then be closed with a small drain, dressed antiseptically, and the head and neck firmly held by a plaster-of-Paris bandage.

It should be remembered that efforts at reduction have occasionally caused sudden death when the injury was located high in the cervical region.

As dislocation unaccompanied by fracture practically never occurs below the cervical region, the reader is referred to the section devoted to Fractures of the Spine for a consideration of these injuries in the dorsal and lumbar regions.

Dislocations of the Sternum.

Bony union of the three portions of the sternum occurs late in life if at all, rarely before the fortieth year. Before ossification takes place separations may occur at the lines of union, giving rise to two varieties of dislocation : those of the body from the manubrium, and those of the ensiform.

Dislocations of the body from the manubrium are generally produced by some violent crushing force, and are often accompanied by other injuries.

The **symptoms** are localized pain, which is increased by respiratory efforts, and the presence of an elevation of the upper border of the gladiolus, which can be easily palpated under the skin. This transverse ridge lies at the point of junction of the second costal cartilages ; and as these generally remain attached to the manubrium, there is on either extremity of this ridge a small depression caused by separation of the cartilages.

The **treatment** is the same as in fractures of the sternum. Reduction is accomplished by direct pressure aided by dorsal flexion of the trunk, after which the movements of the chest should be limited by a tight binder.

Dislocations of the ensiform are exceedingly rare, and are produced by direct violence or tight lacing. The base of the ensiform may be displaced backward, or its tip may be directed inward, toward the spine, at right angles to the body of the sternum.

The **symptoms** are pain, which is increased by motion or taking food. In several reported cases persistent vomiting was the most prominent symptom.

Treatment.—Reduction is best accomplished by incision and replacement of the bone, with suture, if necessary, to prevent recurrence.

Dislocations of the Ribs.

A few examples of dislocation of the head of the ribs from the vertebral column have been reported, generally accompanied by fractures of the spine or other severe injuries. Separation of the ribs from their costal cartilages, or of the costal cartilages from the sternum, or from each other, has also been occasionally observed. As these injuries are similar in their etiology, symptomatology, and treatment to fracture of the ribs, the reader is referred to the chapter on Fractures for their diagnosis and management.

Dislocations of the Shoulder.

Dislocations of the shoulder are the most frequent of all dislocations, in fact statistics show that they occur more often than all other dislocations combined. The causes of this frequency are in their order of importance: the large range of motion in the joint, the frequent strain of injury, and the shallowness of the glenoid cavity.

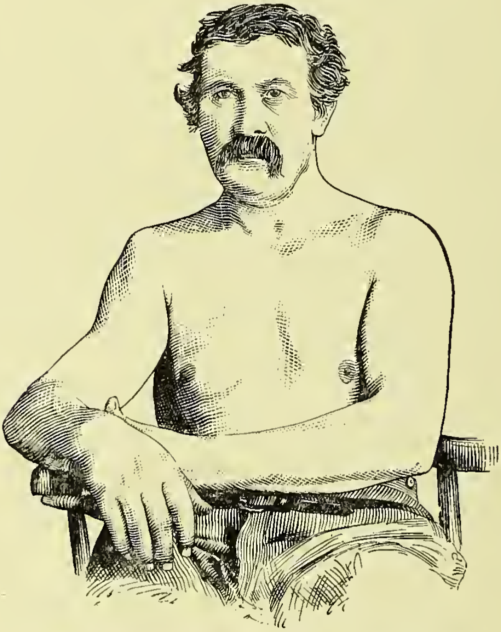
Causes.—Dislocations of the shoulder are caused both by direct and indirect violence. Direct violence may cause dislocation by a fall on the point of the shoulder, but more commonly by a blow on the upper part of the arm while it is abducted or raised above the head, the direction of the blow being such as to drive the head of the bone away from the glenoid cavity. Indirect violence causes dislocation generally by a fall on the hand or elbow. Muscular action not infrequently acts as a contributing cause, as evidenced by the frequency of dislocations occurring during athletic sports, especially wrestling.

Shoulder dislocation is essentially an injury of middle adult life, the same cause producing fracture of the clavicle or dislocation of the elbow in early life, and not infrequently fracture of the neck of the humerus in later life.

Varieties.—The following are the varieties of shoulder dislocation, in the order of their frequency: subcoracoid, subglenoid, subspinous, subclavicular, and supracoracoid.

In the *subcoracoid* variety (Fig. 353), which is by far the most common, the capsule is ruptured anteriorly, allowing the head of the bone to protrude through the rent. The head rests under the coracoid process generally above the tendon of the subscapularis, although the fibres of this muscle may be ruptured or pushed forward, embracing the head of the bone. If the articular surface of the humerus is in contact with the margin of the glenoid, this dislocation is often spoken of as *incomplete;* if the head is pushed partly beyond the coracoid, the term *intracoracoid* dislocation has been suggested; if completely beyond the coracoid, the dislocation should be classed as *subclavicular.*

FIG. 353.



Subcoracoid dislocation of the left shoulder. (Stimson.)

In the *subglenoid* variety the lower portion of the capsule is ruptured; the head of the humerus rests below the glenoid fossa on or in front of the axillary border of the scapula below the tendon of the subscapularis. In extreme downward displacement of the head of the bone the arm may remain erect, the elbow being usually flexed and the forearm resting behind the head; this rare form is described as the *luxatio erecta*. Certain authorities believe that most dislocations are primarily subglenoid, the injury being received while the arm is raised above the head, and that the head of the bone originally lying beneath the glenoid fossa subsequently assumes a position under the coracoid by lowering the arm or other active and passive movements.

In the *subspinous* variety the head of the bone passes through a rent in the posterior portion of the capsule, and rests below the spine of the scapula between the infraspinatus and teres minor muscles, covered by the deltoid.

The *supracoracoid* variety is extremely rare, and is usually accompanied by fracture of the coracoid or acromion; the head of the bone is displaced upward and rests upon the coraco-acromial ligament.

Symptoms and Diagnosis.—The symptoms of a dislocation of the shoulder are pain and inability to use the limb. The signs are, on inspection, deformity due to flattening of the shoulder, prominence of the acromion, alteration in the axis of the arm, a swelling in the region of the displaced head of the bone; on palpation, absence of the head of the bone from the glenoid fossa, presence of the head of the bone in some abnormal position, muscular rigidity causing diminished motion of the joint, absence of crepitus, and inability to bring the elbow in contact with the chest when the hand is placed on the opposite shoulder; on mensuration the limb is found to be lengthened in the subglenoid, and shortened in all other dislocations. When considerable swelling exists, obscuring these signs, an x-ray examination is desirable, especially in cases in which both fracture and dislocation are suspected.

Complications.—Aside from the contusions often present from the original trauma, complicating injuries are comparatively rare. Pressure on the nerve-trunks or the larger vessels may give rise to numbness and circulatory disturbances in the arm; injury to these structures occasions paralysis and hæmatomata. Of the nerves, the circumflex is the one most frequently affected; and the symptoms, if at all prolonged, are probably due to a neuritis from the trauma of the original injury or the attempts at reduction. Of the vessels, the circumflex and subscapular are the ones generally torn, and wounds of the axillary artery and vein have been reported.

Laceration of the muscles attached to the greater and lesser tuberosities, or fractures at the points of their attachment, may occur, and by their retraction produce a permanent weakening of the joint and a tendency to habitual dislocation. Fractures of the anatomic or surgical neck of the humerus occasionally occur as a complication of dislocation at the shoulder, and present serious difficulties in treatment. Fractures of the acromion, coracoid, and glenoid are also occasionally present, the former generally associated with supracoracoid dislocation.

Treatment.—Two methods are in general use: reduction by extension or traction, and reduction by manipulation. The former is the older; the latter, the modern method.

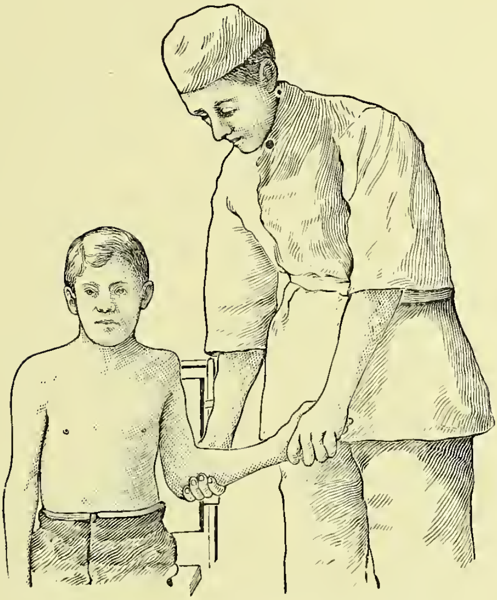
Reduction by Extension.—The usual method is to place the patient on a table and make counterextension by a sheet carried around the thorax and firmly held by an assistant. The surgeon then grasps the affected arm near the wrist and applies traction outward at a right angle with the body. Steady traction for a few seconds will generally cause the contracting muscles to relax, after which the head of the bone usually slips into place. Another method, formerly extensively employed, is that of the "heel in the axilla." The patient lies upon his back on the floor or on a bed; the surgeon sits facing the patient on his injured side, and after removing his shoe places the heel in the axilla, grasping the wrist of the patient with his hands or by means of a clove-hitch; steady traction is made downward, using the heel as a lever to force the head of the bone toward the glenoid cavity. The method is often successful, but is inferior to that of outward traction, and is said to be responsible for a number of injuries to the vessels and nerves.

In the rarer forms of dislocation the direction of the traction may with advantage be altered to meet the requirements of the case, such as traction upward in the luxatio erecta and downward in the supracoracoid dislocation.

Method by Manipulation (*Kocher*).—Place the patient on a chair or stool, flex the elbow, and, keeping the arm close to the side of the thorax, rotate the humerus outward until the flexed forearm is parallel with the transverse plane of the body; then holding the forearm in this position, carry the elbow slowly upward along the anterior surface of the chest until it reaches a point opposite the ensiform; quickly rotate the forearm inward until the hand touches the opposite shoulder and lower the elbow. The head of the bone may slip into place during any of these motions (Figs. 354, 355, and 356).

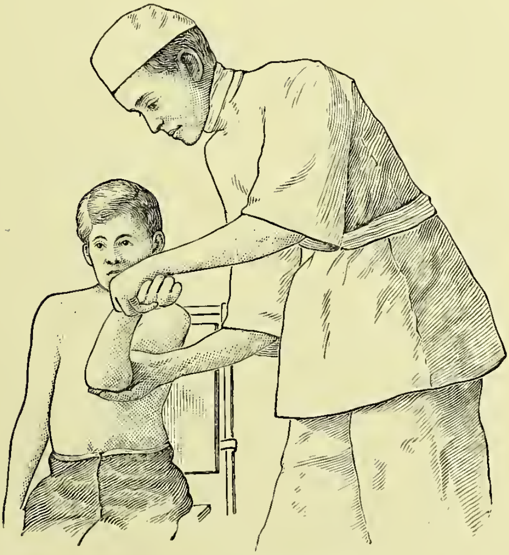
This method is chiefly applicable to the subcoracoid variety; and if uncomplicated, reduction is easily accomplished in the majority of instances. It may fail, however, if the displacement is markedly inward and downward, or if the capsule is extensively

FIG. 354.



Kocher's method of reduction: first position.

FIG. 355.

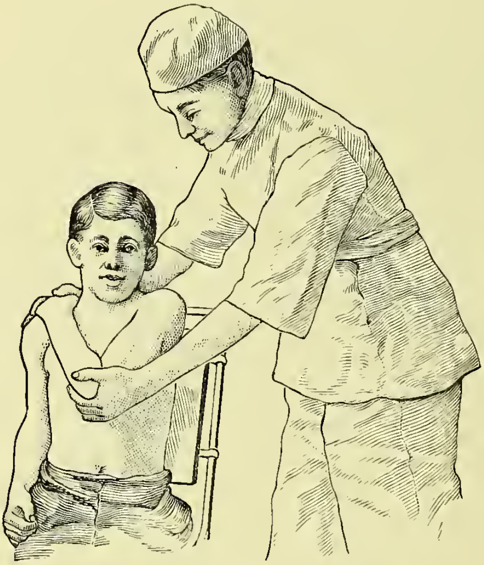


Kocher's method: second position.

lacerated. Under these conditions extension is to be preferred. While reduction of dislocations at the shoulder may usually be accomplished without general anæsthesia, it is frequently desirable to employ it, not only to relieve the pain necessarily incident to the manipulation, but also to overcome muscular spasm.

The employment of forcible reduction by means of compound pulleys, especially in old dislocations, as suggested and practised by the older surgeons, is not to be recommended. If a recent dislocation cannot be reduced by the expenditure of a moderate degree of force, it is because some mechanical obstruction exists which is best removed by open operation.

Fig. 356.



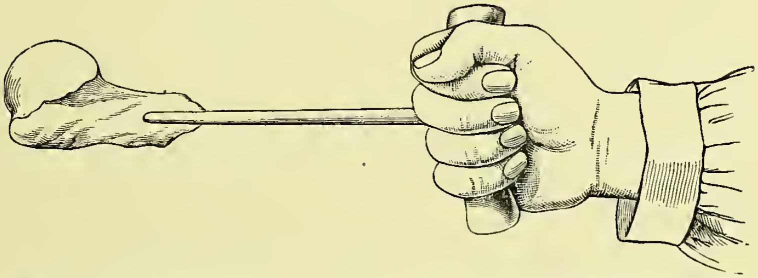
Kocher's method: third position.

If the dislocation is complicated by a fracture of the neck of the humerus, it should be treated by open operation, reduction of the upper fragment being accomplished after the parts are thoroughly exposed, by means of the McBurney hook (Fig. 357), or by the use of elevators and other prying instruments. In old injuries of this kind excision of the head of the bone is often necessary.

In the reduction of *old dislocations* of the shoulder, one should remember that the resulting motion is often less than that obtained by allowing the head of the bone to remain in its abnormal position, where a false joint generally forms and a fair amount of motion develops. Moreover, such attempts in the presence of dense adhesions not infrequently result in fracture, or injury to important vessels and nerves. If such an attempt is to be made, ether should be given, and the adhesions gradually broken up by various motions of the shoulder until the bone is freely movable, after which reduction may be attempted by manipulation or extension. If the adhesions are not readily broken up by a moderate amount of force, or if there is some evident mechanical impediment to reduction, an open operation is to be advised and the procedures carried out under guidance of the eye.

After reduction has been accomplished the arm should be kept moderately quiet for two or three weeks until the wound in the capsule unites. This is accomplished best by the sling and body-binder at first (Fig. 65), and later the sling only may be used. Passive motion in uncomplicated cases should be begun after the second or third day, and at the end of a week in operative cases.

Fig. 357.



McBurney's hook for making traction upon the dislocated upper fragment. (Stimson.)

Complete restoration of function is to be expected in recent uncomplicated cases. Regarding the amount of motion to be obtained after reduction of old or complicated dislocations, the prognosis should be guarded. Much may be accomplished by persistent efforts at passive or active motion, by massage, baths, and electricity.

Dislocations of the Elbow.

Dislocations of the elbow are of frequent occurrence, especially in children. As has been pointed out, they are generally produced by a fall on the hand, the arm being extended, an injury which in adult life is likely to cause dislocation of the shoulder, or occasionally a fracture of the surgical neck of the humerus. Both bones may be dislocated backward, forward, inward, or outward; the radius alone may be displaced backward, forward, or outward; the ulna backward, forward, or inward. The classification is extended still further by the use of the terms complete and incomplete in connection with any of these varieties, and by describing a given injury as a combination of two forms, as a dislocation backward and outward.

Backward dislocation of both bones is very common; all other forms are comparatively rare.

In backward displacements of both bones the injury is almost always produced by a fall upon the extended hand. The ability which most children possess to hyperextend slightly the arm may be partly responsible for the frequency of this dislocation in early life. Both bones of the forearm are displaced backward, the coracoid process of the ulna resting in the olecranon fossa, the head of the radius behind the external condyle. If the coracoid process still rests upon the trochlea, the dislocation may be termed incomplete. With this injury there is always considerable laceration of the ligaments; the coracoid process may be broken or the brachialis anticus muscle torn from its attachment.

In *forward dislocations*, which are extremely rare, the injury is produced by a fall or blow on the point of the elbow while the forearm is acutely flexed. Considerable more force is required to produce this injury, and the accompanying laceration of the tissues is greater in extent. The olecranon may lie wholly in front of the condyles, or its tip may rest upon the articular surface.

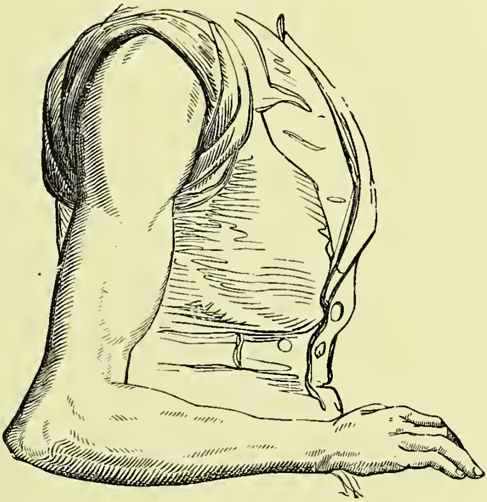
In *lateral dislocations*, of which the inward is somewhat more common, luxation is seldom complete. In the *external* variety the sigmoid cavity of the ulna rests upon the capitellum, the radial head lies external to the condyle. In the *internal* variety the sigmoid cavity lies in contact with the extra-articular portion of the internal condyle, and the head of the radius is generally in front of the articular surface and somewhat below it. In *mixed dislocations*, backward and outward, or backward and inward, the primary injury is probably the backward one, the lateral displacement occurring secondarily to it.

Dislocations of the ulna alone are extremely rare, the backward displacement being the one most frequently reported.

Dislocations of the head of the radius are comparatively common, and are often accompanied by fracture of the shaft of the ulna. The forward displacement is commonest; next in frequency comes the backward; the outward is very rare.

Diagnosis.—In all dislocations of the elbow there is a history of injury followed by localized pain and inability to use the joint. In backward dislocations of both bones the arm is semiflexed and supinated, the forearm appears shortened when viewed from in front, the humerus appears shortened if viewed from behind; there is a distinct prominence of the olecranon, the normal relations between it and the epicondyles is lost, the articular surface of the humerus may be felt in front of the joint below the natural crease in the skin, and the head of the radius may be palpated behind the external condyle (Fig. 358). In the rare forward displacement the arm is in partial flexion; the olecranon no longer forms a primary point on the posterior aspect of the joint, the forearm is lengthened, and the displaced bones may be readily felt in front of the joint. In lateral dislocations the diagnosis is usually made without difficulty, for in the complete outward luxation the deformity is so great that it could hardly be mistaken for any other condition, and in partial lateral displacements the signs are generally sufficiently characteristic to enable one to arrive at a correct diagnosis in the absence of great swelling or other complicating injury. Thus in the external variety the rounded head of the radius can be felt moving with rotation of the forearm to the outer side of the condyle; while in the internal variety the olecranon and sigmoid cavity of the ulna can be readily appreciated, lying to the inner side of the internal condyle. In each variety there is a prominence above on the opposite side of the joint, formed by the overhanging condyle and articular surface of the humerus. Dislocation of the ulna alone may be recognized by the

Fig. 358.



Backward dislocation of radius and ulna. (Ashhurst.)

altered relations of the olecranon and condyles, by the presence of the radial head in its normal position, and by palpating the olecranon and sigmoid cavity in an abnormal locality. Dislocation of the head of the radius is recognized by the history of injury, pain in the joint, the inability to flex the arm beyond a right angle or to supinate without pain. In the anterior variety the arm is partly flexed and in a position midway between pronation and supination ; the head of the bone can be felt in front of the joint just above the external condyle. In the posterior variety there is an outward inclination of the arm, and the head of the radius may be felt posteriorly. In external displacement the joint is widened, the arm inclined outward, and the head of the bone easily palpated to the outer side and above the condyle.

Subluxation of the head of the radius occurs frequently in young children, and almost always from lifting the child by one hand. The symptoms are sudden pain and inability to use the arm. The anatomic relations of the joint appear normal; there is tenderness over the head of the radius with inability to supinate without pain. Other motions are free but very painful.

Complications.—Dislocations of the elbow are rarely compound. Fractures of the coracoid process and olecranon are fairly common complications of backward dislocation. Fracture of the shaft of the ulna is a frequent complication of dislocation of the head of the radius. The occurrence of fracture of the head of the radius, external or internal condyle of the humerus, has also been observed. Injury of the brachial artery or of the median or ulnar nerve occasionally occurs.

Treatment.—The method usually employed in the reduction of backward dislocations at the elbow is the following : The patient is seated in a chair. The surgeon places his foot upon the chair and his knee in the bend of the elbow. By grasping the wrist and forcibly flexing the arm over the knee reduction is usually accomplished. Stimson points out that this method, although generally successful, is faulty in that it stretches or lacerates structures not ordinarily injured by the original trauma. He recommends steady traction, the arm being extended until the coracoid process is drawn well below the olecranon fossa, then forward pressure on the displaced bones with gradual flexion. If the coracoid process is not readily disengaged by simple traction, slight pronation, hyperextension, or direct pressure backward on the upper part of the forearm will serve to lift it out of the olecranon fossa.

In dislocations of the head of the radius, extension followed by flexion and direct pressure on the head of the bone will usually serve to effect reduction. In the other rare forms of displacement, extension followed by flexion and direct pressure on the displaced bones is the method to be recommended. In all dislocations, especially if difficulty is experienced in reduction, general anæsthesia should be used.

The after-treatment should consist in fixation of the joint by an angular splint or sling and body bandage until the torn structures are healed. Passive motion should be employed after the swelling and pain have subsided.

If in backward dislocations the coracoid process is fractured, the arm should be held in a position of flexion to a degree somewhat more than a right angle, and passive motion should be delayed until union has taken place.

Old dislocations may occasionally be reduced by first breaking up the adhesions by forced flexion and extension, and then applying strong traction and the various methods employed in recent cases. The writer saw a backward dislocation reduced in this manner seven months after the injury. In the majority of instances, however, it is safer to perform an open operation and replace the bones under guidance of the eye.

Dislocations of the Wrist.

The **inferior radio-ulnar articulation** is not infrequently separated in Colles' fracture and in injuries about the wrist. In these cases the inferior extremity of the ulna is displaced outward and downward, as evidenced by the increased distance between the two styloid processes. Forward or backward dislocations of the inferior extremity of the ulna unassociated with Colles' fracture are rare, and are generally caused by forcible pronation or supination. In these cases the distance between the two styloid processes is diminished, and the projecting extremity of the ulna is readily recognized above or below the radius and often overriding it. Reduction is generally effected by traction and pressure over the displaced bone, aided, if necessary, by pronation and supination.

Dislocations at the **radiocarpal articulation** are rare, and are caused generally by falls upon the palm or back of the hand, the former producing a dislocation backward of the carpus, the latter a dislocation forward. In the backward dislocation the deformity resembles that produced by a Colles' fracture. It is to be distinguished from the fracture, however, by the fact that the normal relations exist between the two styloid processes; that the joint is not widened; that the smooth surface of the projecting carpal bones may be felt lying above the radius; and by the absence of crepitus and ease of reduction. In the forward dislocation the radius and ulna form a prominence on the back of the wrist, while the displaced carpus projects in front. These dislocations are easily reduced by traction and direct pressure, after which a splint should be worn for a week or ten days.

Dislocations at the **mediocarpal articulation** have been reported, but are exceedingly rare. The separation takes place between the first and second rows of the carpus. The hand with the second row of carpal bones may be displaced both backward and forward. Reduction is generally easy.

Dislocations of the **individual bones of the carpus** are occasionally observed. Of these, the *semilunar* is the one most frequently displaced, and the dislocation is generally forward. It is not infrequently associated with fracture of the scaphoid. In these cases the proximal fragment of the scaphoid may be displaced forward with the semilunar bone. Next in frequency comes the *os magnum*, in which the displacement is generally backward. The others are rarely displaced alone. These injuries are generally produced by forced flexion or extension at the wrist; they are occasionally compound, and reduction is often difficult or impossible. The diagnosis may be established by observing the relations of the displaced bone to the radius, ulna, metacarpal bones or tendons, by the shape of the projecting mass, or by an x-ray examination. In the semilunar dislocations, the displaced bone can be felt on the flexor aspect of the wrist, pushing forward the flexor tendons of the fingers, which are thereby rendered tense, producing flexion of the digits. In the *treatment* of semilunar dislocations, the hand should be hyperextended, then gradually flexed, pressure being made upon the displaced bone. In recent cases this manœuvre generally succeeds. Reduction of the other bones generally can be effected by traction and pressure combined with forcible flexion and extension. In compound dislocations and in many simple injuries, when replacement is impossible and when the resulting disability is great, removal of the bone is to be advised.

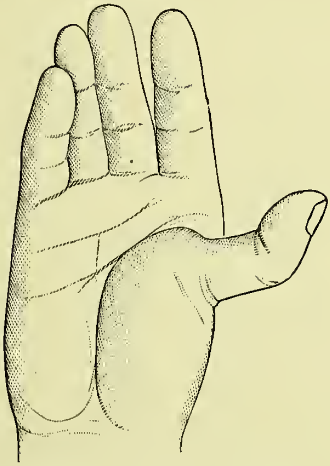
Dislocations at the **carpometacarpal** articulations are exceedingly rare. The *first metacarpal* bone is the one most frequently displaced, and the direction of the displacement is usually backward, caused by some force applied to the thenar eminence. The thumb is shortened and flexed; the proximal extremity of the metacarpal bone rests upon the trapezium, forming a prominence between the extensor tendons of the thumb. The trapezium may be felt on the palmar surface. Dislocation of most of the other individual metacarpal bones has been recorded, as well as two or more together. In a few instances the four inner bones have been displaced forward or backward, and one or two examples of luxation of all five have been reported.

Dislocations of the Bones of the Hand.

Dislocations at the **metacarpophalangeal joints** are more common injuries than the preceding, and are generally single. The thumb is the one most frequently involved; next in frequency comes the index finger. The others are rare.

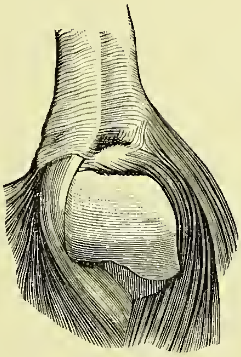
Dislocation of the first phalanx of the thumb backward on the metacarpal bone is an injury which has received a great deal of attention from surgeons on account of the difficulty sometimes experienced in its reduction. The cause of this injury is forcible overextension of the thumb. (Many children can produce an incomplete luxation of this joint by muscular action.) The proximal phalanx is extended; the distal, partly flexed (Fig. 359). The distal extremity of the metacarpal bone buttonholes the muscles on the palmar surface and can be felt below. The tendon of the flexor longus pollicis may be pushed forward by the head of the bone or displaced to the inner side (Fig. 360).

Fig. 359.



Backward dislocation of thumb. (Stimson.)

Fig. 360.

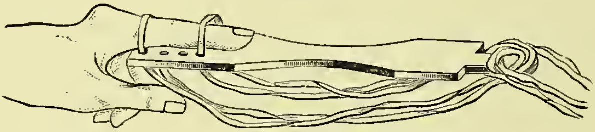


Position of head of metacarpal. (Stimson.)

In order to reduce this dislocation it is necessary to relax the muscular structures which surround the head of the metacarpal bone. This is accomplished best by adducting the thumb strongly into the palm. The extended phalanx should then be drawn downward until its articular surface is in contact with that of the metacarpal bone, after which it should be strongly flexed. When reduction cannot be accomplished by this procedure the cause of the difficulty may be, according to Stimson, the torn edge of the anterior ligament of the joint which rests across the upper surface of the head of the metacarpal bone. In these cases open arthrotomy, the incision being made in the direction of the flexor tendon, on the palmar surface, is to be advised, rather than prolonged efforts at traction. Forward dislocations at this articulation are rarer and more easily treated. They are generally caused by forcible overflexion. The phalanx lies in front of the metacarpal bone, which is seen to project posteriorly. Reduction is accomplished by traction, flexion, and direct pressure.

Forward or backward dislocations at the other metacarpophalangeal joints are easily recognized and reduced by traction and direct pressure. Difficulty may occasionally be encountered in firmly grasping a finger in order to exert sufficiently vigorous traction. In these cases the Levis splint may be employed (Fig. 361).

Fig. 361.



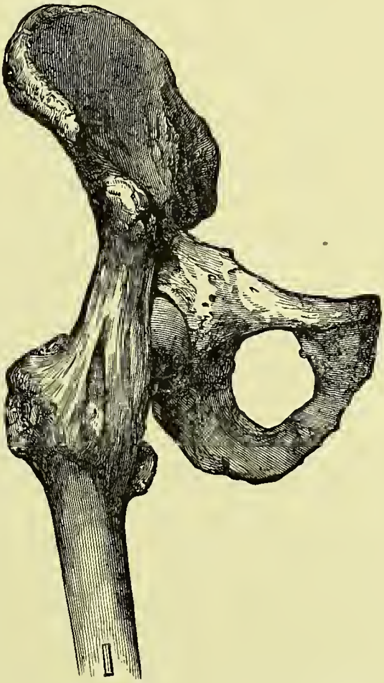
Levis extension apparatus.

Dislocations at the **first and second phalangeal joints** are comparatively common, and result from injuries received in baseball and other athletic sports, as well as from blows and falls. The diagnosis presents no difficulties unless the parts are extensively bruised and swollen. Reduction is accomplished by traction and direct pressure.

Dislocations of the Hip.

The hip is a large ball-and-socket joint of great solidity. It is rarely dislocated. The reason of its unusual strength lies in the fact that although the range of its motion is large, its socket is deep, its ligaments tough, and its surrounding muscles heavy and firm. Another element which serves to prevent the head of the bone from leaving its socket is atmospheric pressure. The acetabular cavity is almost hemispherical, and the head of the femur fits its hollow so accurately that air cannot enter until its complete removal, which requires a very considerable amount of force. The weakest part of the acetabular rim is below, owing to the thinness of the bone and the presence here of the cotyloid notch. The capsular ligament, which is attached to the pelvis at the circumference of the acetabulum, and to the femur at or near the junction of the neck with the shaft, is thickened at several points, forming the *iliofemoral*, *pubofemoral*, and *ischiofemoral ligaments.* Of these, the most important is the iliofemoral or Y-ligament of Bigelow, which passes from the anterior inferior spinous process, downward on the capsule, as a thick band of dense fibrous tissue, dividing at about the middle of the anterior surface of the capsule into two bands, one passing to the greater and one to the lesser trochanter (Fig. 362). This ligament is said by Bigelow to be capable of sustaining a strain of from 250 to 750 pounds.

Fig. 362.



The iliofemoral, or Y-ligament. (Bigelow.)

The weakest part of the capsule is at its inferior and posterior portion. When the thigh is flexed, adducted, and rotated inward, the posterior inferior portion of the capsule is rendered tense, and if any force is then applied to the body or limb to increase this strain upon the ligament it may rupture and the head of the bone be forced out of its socket. Thus one of the most frequent causes of dislocation at the hip is a blow from some heavy falling object received on the back of a person in a stooping position. It is probable that in most dislocations the head of the bone leaves the socket at this point, and its ultimate location will depend largely upon the direction of motion in the affected limb immediately after the receipt of the injury. Thus if the limb, after the head of the bone leaves the socket, is abducted and rotated outward, the head will follow the rim of the acetabulum in an inward direction and lodge in the thyroid foramen or on the pubis; whereas if the leg is adducted and rotated inward, the head of the bone will pass to the outer side of the acetabular rim and lodge in the sciatic notch or on the dorsum of the ilium. Exaggerated secondary motion of the limb in either direction may carry the head of the bone to a point immediately above the acetabulum. That the head of the bone takes one of these directions and lodges generally at or near a point which gives to the luxation the name *iliac*, *sciatic*, *thyroid*, or *pubic*, is due largely to the integrity of the iliofemoral ligament. If the trauma is of sufficient severity to rupture this band, the dislocation may become compound, or the head of the bone be driven to some unusual position, constituting one of the irregular forms occasionally encountered. Dislocation of the hip is essentially an injury of early or middle adult life. It is most frequently observed in individuals between fifteen and thirty years of age, although cases have been reported as occurring at any age between six months and ninety-one years. It is far more frequent in men than in women, the proportion being about 8 to 1.

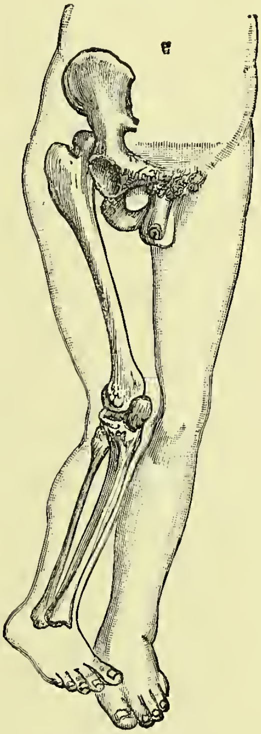
Classification.—In spite of the many elaborate classifications which have been suggested for dislocations of the hip, the profession generally still employs the old terms *iliac*, *sciatic*, *thyroid*, and *pubic*, to describe the common varieties. In the writer's opinion, it is far more important to recognize the method of production of these different varieties and the probable course taken by the head of the bone in reaching its abnormal location, than to seek to establish a more scientific classification. Four regular dislocations, the iliac, the sciatic, the thyroid, and the pubic, will therefore be described, and three irregular forms, the supracotyloid, the infracotyloid, and the perineal.

Diagnosis.—In all cases there is a history of some severe injury followed by pain about the joint and inability to use the limb. Deformity is always present, its character depending upon the variety of the dislocation. There is greatly diminished mobility at the joint, and all movements of the limb cause accentuation of the pain. True bony crepitus is absent, but a sensation suggesting crepitus is often imparted to the hand by moving the limb, caused by the rubbing of the head of the bone against the torn muscles and ligaments.

In addition to these, each variety has it own characteristic signs, which will be enumerated separately.

Iliac Dislocation.—The head of the bone in this variety rests upon the dorsum of the ilium above the tendon of the obturator internus muscle. When the patient rests in the dorsal position, the thigh will be seen to be partly flexed, adducted, and inverted; the long axis of the femur, if continued, would cross the opposite thigh at the junction of the middle with the lower third (Fig. 363). Flexion and adduction are tolerated but painful; extension and abduction impossible. The knee is slightly flexed, and the ball of the great toe rests often on the dorsum of the opposite foot. There is considerable shortening, the great trochanter lies above Nélaton's line, the fascia lata is relaxed, and the head of the bone may often be felt in its abnormal position. If the capsule is extensively lacerated and the outer portion of the Y-ligament torn, the head of the bone may lie immediately above the acetabulum and the limb assume a position of marked eversion. This, however, is extremely rare.

Fig. 363.



Iliac dislocation. (Tillmanns.)

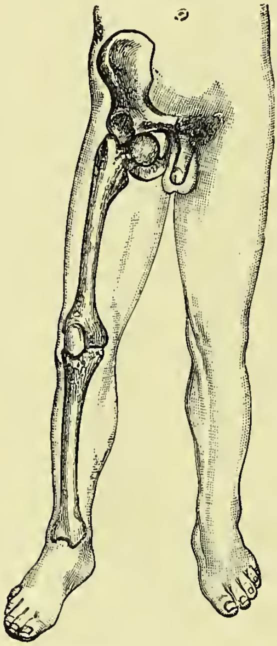
Sciatic Dislocation.—In this variety the head of the bone lies on the ischium near the sciatic notch, below the tendon of the obturator internus. The symptoms in general resemble the iliac dislocation, but are less marked. There are slight shortening, slight flexion, slight inversion and adduction; the axis of the affected thigh, if extended, would pass through the opposite knee. If both thighs are brought to a right angle with the body, the patient being in the recumbent position, the shortening of the affected thigh is materially increased.

Thyroid Dislocation.—The limb is lengthened, abducted, and slightly everted. The trochanter is below Nélaton's line. There is slight flexion at the hip from tension of the psoas and iliacus. In the recumbent position the limb cannot be fully extended, and the knees cannot be approximated without severe pain. There is spasm of the adductor muscles (Fig. 364).

Pubic Dislocation.—The limb is shortened, abducted, and markedly everted. The head of the bone can generally be felt internal to the anterior inferior spinous process, resting on the horizontal ramus of the pubes; or, rarely, above it (suprapubic variety). The hip is flattened; the prominence normally formed by the great trochanter is absent; adduction and internal rotation are exceedingly painful (Fig. 365).

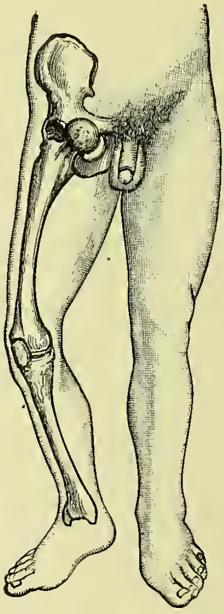
Of the rare irregular dislocations, the *supracotyloid* resembles somewhat the dorsal with eversion, or the pubic, but it differs from them in that it is caused by some severe injury which forces the head of the bone directly upward through a rent in the strong anterior portion of the capsule. There is shortening, with marked eversion and abduction. The head of the bone may easily be palpated just below the anterior superior spinous process.

FIG. 364.



Thyroid dislocation. (Tillmanns.)

FIG. 365.



Pubic dislocation. (Tillmanns.)

In *infracotyloid* dislocation there are lengthening and generally marked flexion, with either slight inversion or eversion of the foot. The head of the bone is directly below the acetabulum and rests on the ischium. It is probably the primary stage of many dislocations which are subsequently converted into one or another of the four regular forms.

The *perineal variety* is exceedingly rare. In it there is extreme abduction with flexion. The head of the bone rests in the tissues of the perineum, where it occasionally presses upon the urethra, causing retention of urine.

Complications.—Compound dislocations of the hip are exceedingly rare. Fractures of the pelvis or of the neck or shaft of the femur are occasionally encountered, the latter produced sometimes by attempts at reduction. Laceration of the femoral vessels has been reported; also injury to the sciatic nerve. Simultaneous dislocation of both hips has been recorded in a few instances.

Prognosis.—In recent cases reduction can generally be accomplished and a good functional joint expected. In old cases efforts at reduction are attended with considerable risk, chiefly of fracture of the neck or shaft of the femur. The functional result in old, unreduced dislocations is occasionally fair, especially in the thyroid variety, as Nature will sometimes form a new and comparatively strong joint, allowing a considerable amount of mobility. In the other varieties much disability results from the shortening, limited motion, and lack of parallelism of the limbs.

Treatment.—In hip dislocation, perhaps more than in any other, the rule should be observed of causing the dislocated head of the bone to follow backward its path to the socket. The methods of manipulation popularized by Bigelow and now generally practised by the profession have wholly replaced the older and unscientific procedures, formerly practised, of forcible traction by pulleys, etc.

Bigelow's methods are carried out in the following manner: The patient should be thoroughly anæsthetized and placed on his back on the floor; the pelvis should be steadied by an assistant. The surgeon grasps the ankle of the affected limb with one hand and the knee with the other. The leg is then flexed to a right angle with the thigh and the thigh to a right angle with the body. In the posterior displacements the thigh is then further flexed, adducted, and rotated inward; the knee is then circumducted externally, and while this is being done direct sudden upward traction is made, after which the leg is extended and brought to the floor. In the anterior displacements the thigh is flexed and abducted, then circumducted internally with upward traction and rotation, and finally fully extended. In the rare dorsal dislocations with eversion, the displacement should first be converted into a regular dorsal dislocation with inversion by flexion and inward rotation, then replaced by the method just described for dorsal dislocations, or simply by upward traction in the flexed position.

In irregular dislocations with extensive laceration of the capsule, direct traction upward with the thigh flexed at a right angle with the body, and direct pressure toward the acetabulum on the displaced head of the bone, will usually succeed.

Dislocations of the Patella.

The patella may be dislocated outward, inward, and by rotation on its longitudinal axis.

In the *outward variety*, which is the commonest, the patella lies to the outer side of the external condyle. If unaccompanied by rotation, its inner edge only is in contact with the condyle. Generally, however, a certain degree of external or internal rotation is present, which allows either its anterior or posterior surface to come into contact with the condyle. It is caused by direct violence, as a blow on the inner edge of the bone, or by muscular action, especially in a condition of genu-valgum.

In the rare *inward dislocations* the bone lies to the inner side of the joint, beyond the articular surface of the internal condyle, in contact with the condyle only by its external border; or if rotation exists, by its anterior or posterior surface. This variety is usually the result of direct violence.

In the *dislocations by rotation* of the patella on its longitudinal axis three degrees are recognized: first, partial rotation with lateral displacement, when the outer or inner edge of the patella lies in the intercondyloid notch, the bone resting on the external or internal condyle, the so-called incomplete external or internal dislocation; second, when the rotation is through a larger arc, so that one edge of the patella rests in the intercondyloid notch and the other points vertically upward, the so-called edgewise dislocation; and third, when complete rotation has taken place, the anterior surface of the patella resting upon the articular surface of the femur, and the articular surface of the patella lying immediately underneath the skin.

All of these rotary displacements are caused by direct violence applied to the outer or inner edge of the bone, generally during moderate flexion of the knee.

Diagnosis.—This is generally easy. In the lateral displacements the joint appears widened, with an irregular projection on the side of the displacement. The normal prominence of the patella is absent and a depression exists between the condyles. The bone may easily be recognized by palpation in its abnormal position. There are pain and immobility of the joint. In rotary displacements the position of the bone may be readily made out by inspection and palpation.

Treatment.—In all of these dislocations the thigh should be flexed on the body and the knee fully extended to relax the quadriceps extensor muscle. When this is accomplished, reduction may easily be effected by pressure on the displaced bone. After reduction the joint should be immobilized for a week or more, and later treated by massage and hot and cold douches if synovitis exists. Any tendency to redisplacement should be combated by a knee-cap or elastic bandage.

Dislocations of the Knee.

Dislocations of the knee are rare, and are generally the result of severe injury. They are frequently compound, and often are accompanied by grave complications. They are classified according to the direction taken by the displaced tibia, and in the order of frequency are forward, backward, outward, inward, and by rotation.

Forward dislocation is by far the commonest. It may be complete or incomplete, and is frequently compound. It is caused generally by some severe force resulting in hyperextension of the leg, or by direct violence applied just above and in front of the knee or below and behind. When complete, the popliteal surface at the back of the tibial head rests upon the anterior surface of the condyles of the femur. The overriding of the bones may amount to several inches. The ligaments of the joint are extensively torn; the popliteal vessels and nerves are tightly stretched over the condyles of the femur and may lie in the intercondyloid notch. More or less injury to these structures generally results, especially to the artery, which may be torn or later may become occluded by rupture of its internal and middle coats. The vein is less frequently injured. When compound, the opening is usually behind, allowing the condyles of the femur to protrude.

In *backward* dislocations, when complete, the anterior border of the articular surface of the tibia rests upon the posterior surface of the condyles of the femur. It is caused by direct violence above or below the knee, or by a strong forward motion of the body while the leg is fixed. In this dislocation the ligaments are not, as a rule, so extensively lacerated as in the forward displacements. The patella may be fractured or displaced laterally, or the quadriceps tendon may be torn. The popliteal vessels and nerves are stretched and often injured, as in the forward variety. In incomplete forward or backward dislocations the articular surfaces are not entirely separated, and there is no overriding.

Lateral dislocations are less frequent, and may be complete or incomplete. The *complete* outward or inward luxations are exceedingly rare; the articular surfaces are entirely separated; the head of the tibia lies to the outer or inner side of the femur, producing great deformity. A certain amount of antero-posterior displacement may exist with rotation. The patella and its tendon, if not injured, lie obliquely. In *incomplete* lateral displacements, which are far more common, the outer tuberosity of the tibia rests upon the inner condyle, or the inner tuberosity upon the outer condyle; there is less deformity, and the injury to surrounding structures is less extensive.

In *rotary* dislocations the leg is violently rotated around its longitudinal axis, the ligamentous structures are torn, and one or both condyles are displaced forward or backward.

Diagnosis.—The recognition of these dislocations is generally easy, as the bones are so superficial that any change in their relations is readily appreciated by inspection and palpation. In the complete forms the deformity is great, there is considerable shortening, and the flat articular surface of the tibia is easily felt in its abnormal position.

In the complete *forward* variety the leg is extended, the antero-posterior diameter of the joint is greatly increased, the skin above the patella is relaxed and presents one or more transverse folds, the flattened articular surface of the tibia may be felt in front, and the rounded condyles of the femur behind; the leg is numb and cold from pressure on the popliteal nerves and vessels. The pulse in the posterior tibial and dorsalis pedis vessels may be absent. In complete *backward* displacement the leg is hyperextended, the condyles of the femur are in front and the head of the tibia behind; pressure-symptoms on the nerves and vessels are the same. In complete *lateral* displacements the deformity is so characteristic as to leave no doubt regarding the nature of the injury. In *incomplete* luxations and *rotary* displacements there is no shortening, and, as a rule, no pressure-symptoms. The outlines of the bones can, however, be readily made out, and in the absence of swelling the diagnosis is without difficulty.

Prognosis.—In complete dislocation of the knee the prognosis is grave from the fact that from 20 to 25 per cent. of the cases are compound, and also from the fact that in a large proportion of the forward or backward displacements the popliteal vessels are so injured that gangrene of the leg results. In other instances neuritis develops, and causes grave sensory, motor, and trophic disturbances. In the incomplete varieties the prognosis is more favorable, but more or less impairment of function in the knee-joint is to be expected.

Treatment.—In all varieties of this injury reduction is easily accomplished under general anæsthesia by simple traction and direct pressure over the displaced bone. The presence or absence of pulsation in the arteries of the foot should be noted before and after reduction. Occasionally in thrombosis of the popliteal artery from rupture of its inner coats collateral circulation will be established, and the early treatment should therefore be expectant. If signs of gangrene appear, amputation is indicated. When the circulation is unaffected and reduction is accomplished, the leg should be immobilized for several weeks to allow repair to take place in the torn ligaments; and if considerable inflammatory reaction follows, the use of an ice-bag is to be recommended. Passive motion should be undertaken after the second week and a knee-cap worn for several months.

In compound dislocations the joint should be freely opened, irrigated, and drained. If acute general sepsis follows, early amputation will be necessary to save life.

Dislocation of the Semilunar Cartilages.

The semilunar cartilages of the knee-joint are occasionally displaced inward or outward by some slight injury or unusual motion of the articulation. The inner meniscus is the one oftenest affected, and the displacement is generally accompanied by a bruising or a partial or complete rupture from its being caught and squeezed between the condyle of the femur and articular surface of the tibia. The cause of the displacement is generally a twisting or rotary motion of the body while the feet are firmly placed on the ground and the knee partly flexed. It frequently occurs in athletes, especially those who play football, tennis, or golf. The symptoms of this affection are generally characteristic, and resemble those caused by the presence of a floating cartilage in the joint. They were described in the early part of the nineteenth century by Hey, who called the condition an "internal derangement of the knee." It is only within the past twenty years that the true pathology of the affection has been recognized.

Diagnosis.—As a result of some sudden twisting motion of the leg, the patient immediately experiences a severe lancinating pain in the knee, with "locking" of the joint. The pain is often so severe that the patient falls to the ground and is unable to execute any voluntary movement of the limb. The symptoms may persist for some time and gradually disappear, or as a result of forcibly flexing and extending the leg all pain may suddenly be relieved and the functions of the joint completely restored. There is, however, a strong tendency to recurrence, and patients are often more or less disabled by these frequently recurring attacks. Not infrequently a certain amount of effusion appears in the joint after such an attack, requiring rest in bed and the application of an ice-bag. Examination of the joint may be negative, or in outward displacements of the meniscus a projection may be felt between the articular surfaces of the tibia and femur.

Treatment.—For the acute attack prompt flexion and extension of the leg will often give immediate relief. The pain of this manœuvre is, however, often severe and an anæsthetic is frequently desirable. If tenderness and an effusion into the joint follow the attack, the patient should be kept in bed, the joint immobilized, and an ice-bag applied for several days. To prevent recurrences, the use of a steel brace has been recommended, which prevents rotation and allows only a limited amount of flexion and extension at the knee. Not infrequently, after a large number of such attacks complete relief will follow the giving up of athletics in general or the particular sport which seemed to occasion the symptoms. In many cases, however, the attacks continue in spite of the greatest care, and in these open operation with removal of the injured meniscus or suturing it in place is to be recommended.

Dislocations of the Fibula.

The *upper extremity* of the fibula may be dislocated backward, forward, or upward. These displacements may be caused by direct violence, indirect violence, by an injury to the ankle and upward pressure on the fibula, and by violent contraction of the biceps muscle, the latter producing generally the backward luxation.

The *lower extremity* of the fibula has been displaced backward without fracture in a few recorded cases.

All of these varieties are rare, and are easily recognized. They are generally reduced by direct pressure, aided by flexion of the knee to relax the biceps, in those at the upper end; and by eversion or inversion of the foot in those occurring at the inferior extremity.

Dislocations of the Ankle.

Dislocations of the ankle are fairly frequent, and a large number of varieties have been described. The separation may take place at the tibiotarsal articulation, where the foot with the astragalus may be displaced backward, forward, outward, inward, or upward; at the astragalocalcaneoid and astragaloscaphoid joints, the subastragaloid dislocation, when the direction of displacement of the foot may be backward, forward, outward or inward; at both of these joints, resulting in a displacement of the astragalus alone, which may be forward, backward, inward, outward, or its position simply changed by rotation.

Tibiotarsal Dislocations.—These are generally produced by falls upon the foot in the position of dorsal or plantar flexion, or by strong abduction or adduction of the foot, the former resulting in antero-posterior displacements, the latter in lateral luxations. In the antero-posterior displacements the foot with the astragalus may be displaced backward or forward. The backward dislocation is the commonest.

Symptoms.—In *backward* dislocations the foot is shortened, the heel is prominent, and the tendo Achillis tense; the malleoli project anteriorly and their relations with the tarsus are altered. In *forward* dislocations the foot is lengthened, the heel and tendo Achillis are less prominent, and the space on either side of the tendon is occupied by displaced tibia and fibula. The malleoli are nearer the heel and lower than normal; the articular surface of the astragalus can be felt in front of the tibia. Incomplete backward or forward dislocations may occur, the symptoms of which are the same but less marked.

The lateral dislocations are almost always accompanied by fracture. In the *outward* variety the accompanying fracture is of the fibula, and has already been described as Pott's fracture. In this the dislocation is incomplete, and consists in rotation outward of the tarsus without displacement of the astragalus beyond the malleolus. In the incomplete *inward* variety the inner malleolus or lower part of the tibia is fractured; the rotation of the tarsus is inward. Complete dislocations outward or inward when the astragalus is displaced wholly without the tibiofibular mortice are exceedingly rare. In these the limb is shortened, the ankle is greatly increased in breadth, and the foot is in extreme outward or inward rotation. *Upward* dislocation is exceedingly rare. It is caused by a fall from a height on the feet. The inferior tibiofibular articulation is separated and the astragalus is driven upward between these bones. The joint is widened; the malleoli approach the sole of the foot. It is generally accompanied by fracture.

Treatment.—In all of these dislocations reduction is easily accomplished. In antero-posterior displacements the knee should be flexed to relax the tendo Achillis. The foot should then be grasped by the surgeon and firm traction made while the knee is held by an assistant. This, with pressure forward or backward on the lower extremity of the leg and a slight rocking motion of the foot, will generally succeed. In lateral displacements the reduction of the fracture as well as the dislocation must be made, and in the outward variety the foot should be held in an inverted position by a Dupuytren splint or plaster-of-Paris cast. In dislocations without fracture the joint should be immobilized for ten days, after which massage and passive motion should be employed.

Subastragaloid Dislocations.—In these luxations the astragalus remains with the tibia and fibula. The separation takes place between the astragalus and the scaphoid and os calcis. The displacement of the foot is generally obliquely backward and inward or backward and outward. Dislocations directly backward, or forward, or laterally, are extremely rare. These injuries are caused generally by severe twists of the ankle. They are not infrequently accompanied by fractures of the malleoli.

The **diagnosis** is not always easy in the presence of extensive swelling. In *backward* and *inward* displacements the dorsum of the foot appears shortened, the heel is lengthened, there are inversion of the foot and a prominence externally and in front, caused by the displaced astragalus and external malleolus. In *backward* and *outward* displacements the foot is everted and the astragalus and internal malleolus form a prominence internally and in front. The relation between the head of the astragalus and the malleoli is normal. There is preservation of the antero-posterior movements in the tibiotarsal joint, but the lateral and rotary movements of the ankle are lost or painful.

Treatment.—Reduction is not always easy, owing in certain cases to engagement of the head of the astragalus under the tendon of the tibialis anticus muscle in the backward and outward variety, and occasionally to fracture of the astragalus in the others. Reduction should be attempted in all cases by flexing the knee to relax the tendo Achillis, and by downward and forward traction on the foot, with direct pressure backward, on the lower extremity of the tibia.

Dislocations of the Astragalus.—The astragalus may be forced from its bed and displaced in almost any direction. The cause is generally a fall upon the foot from a height, or any severe twisting injury to the ankle. The most frequent direction of the displacement is forward and outward or forward and inward; occasionally the bone is rotated without being forced out of its bed. In the *forward* and *outward* variety the foot is inverted, and the bone can be easily felt lying in front of the tibia, resting upon the outer tarsal bones. In the *forward* and *inward* variety the foot is everted and the bone can be seen and felt just in front of the internal malleolus. In the rotary displacements little or no deformity may be present but motion is much restricted and painful.

The **treatment** should consist, first, in attempting reduction under anæsthesia by traction and direct pressure over the bone, the knee being held in a flexed position by an assistant, who also exercises strong counterextension. If this fails, open incision and replacement or excision of the bone should be practised.

Mediotarsal Dislocation.—In this dislocation, which is exceedingly rare, the cuboid and scaphoid are separated from the astragalus and os calcis. The displacement is generally downward. In the complete dislocation the foot is shortened, the arch obliterated by the depressed cuboid and scaphoid, and there is a prominence on the dorsum made by the head of the astragalus and the cuboid surface of the os calcis. This dislocation may be accompanied by fracture of one of the bones or of the external malleolus.

Dislocations of the Other Bones of the Tarsus.—These may occur separately or in various combinations. Those of the cuneiform bones are commonest, and of these the first is more often displaced singly than the others.

Dislocation of the *metatarsal bones* may occur singly or in combination. The entire metatarsus has been displaced from the tarsus in a number of cases. These luxations are generally upward, but may occur downward, and in case of the entire metatarsus laterally. The first metatarsal bone is most frequently dislocated singly, and the direction of the displacement is generally upward on the dorsum.

Dislocations of the phalanges are rare, the commonest being at the metatarsophalangeal joint of the great toe. Dislocations at the metatarsophalangeal joints of the other toes and of the terminal phalanx of the great toe have been reported, but are exceedingly rare.

In all of these dislocations the **diagnosis** is made without difficulty in the absence of great swelling. When this is present, an x-ray examination will serve to establish it.

The **treatment** should consist in traction and direct pressure over the displaced bone.

CHAPTER XXIX.

HERNIA.

THE term *hernia*, used in its broad sense, signifies the protrusion of an organ from the cavity in which it is normally contained. As applied to the surgical disease called hernia, or rupture, the term is used in a restricted sense, and refers to a protrusion from the abdominal cavity of one or more of its contained organs through a weakened portion of its wall. This protrusion rests within a pouch made up of certain coverings or tunics. These vary in number and character with the variety of the hernia, one only being constant, and that one is derived from the parietal peritoneum, and is called the *sac* of the hernia. Almost any of the movable abdominal organs may be found in the sac of a hernia. If bowel alone is present, the hernia is spoken of as an *enterocele;* if omentum, *epiplocele;* the term *entero-epiplocele* is sometimes used to describe a hernia containing both intestine and omentum.

Two factors are always present in a given case of hernia, a weakening of the abdominal wall which predisposes the individual to the disease, and the occurrence of increased intra-abdominal pressure, which acts as the exciting cause of the protrusion.

Weak areas of the abdominal wall may be due to prenatal conditions associated with the development of the fœtus, or to acquired conditions occurring after birth and during adult life. Of the former, may be mentioned the separation of the different layers of the abdominal wall in the inguinal region by the descent of the testicle, and the often incomplete union of the structures about the umbilicus. Of the latter, may be mentioned the stretching and subsequent relaxation of the abdominal wall from pregnancy, obesity, ascites, and large abdominal tumors ; weakness and atrophy of the muscles from old age, nerve-lesions, and wasting disease ; and the formation of yielding cicatrices after injuries or surgical operations.

Any condition which produces intra-abdominal pressure may act as an exciting cause of hernia. Thus pregnancy, ascites, and abdominal tumors cause a gradually increasing pressure upon the walls of the cavity ; chronic bronchitis, constipation, and obstructive disease of the urinary passages, may cause intermittent pressure from voluntary or involuntary straining efforts ; and certain occupations, as glass-blowing, the playing of wind instruments, and heavy lifting, are well-known factors in the causation of this disease.

Hernias may be classified from either an anatomic or a clinical point of view.

The anatomic varieties are, *inguinal hernia,* in which the protrusion occurs in the inguinal region ; *femoral,* in which the protrusion occurs through the inner compartment of the femoral sheath ; *umbilical,* in which the disease is limited to the region of the umbilicus ; and *ventral,* in which the protrusion occurs through some other portion of the abdominal wall.

Lumbar, obturator, sciatic, and *perineal* are terms applied to hernias occurring in these regions, all of which are exceedingly rare.

Clinically, hernias may be described as *reducible, irreducible, inflamed, incarcerated,* or *strangulated.*

A *reducible hernia* is one in which the contents of the sac can be returned to the abdominal cavity without a cutting operation. In these cases reduction may often be accomplished by assuming the recumbent posture and making gentle pressure on the tumor. In other cases more or less skilful *taxis* is necessary. This consists in steadying the neck of the sac with the fingers of one hand and gently compressing the sac with the other, slowly forcing the contents through the neck into the abdominal cavity. To accomplish this, in inguinal and femoral hernia, the thigh should be flexed and slightly adducted, and the pressure on the sac made in the direction of the canal through which the hernia emerged. A hot bath not infrequently will relax the muscular spasm and favor reduction by taxis.

An *irreducible hernia* is one in which the contents cannot be returned to the abdominal cavity by taxis. Failure to effect reduction is generally due to the presence of inflammatory adhesions between the sac and its contents. Ninety per cent. of all irreducible hernias contain omentum (Macready).

An *inflamed hernia* is one in which there is an inflammation of the sac or of the sac and its contents. Such cases may be caused by trauma, by too violent or too prolonged efforts at taxis, and by infection from the escape of septic material from the bowel. The symptoms of an inflamed hernia are pain, tenderness, redness, and œdema over a previously normal hernial protrusion, with possibly fever and general malaise.

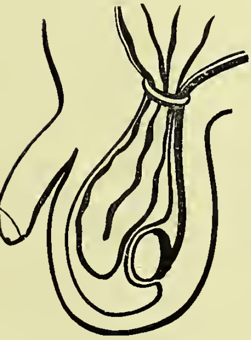
An *incarcerated hernia* (also called obstructed hernia) is one in which there is obstruction to the passage of feces through the bowel, but without interference with the circulation. The obstruction is not necessarily complete, and gas is often passed. This causes coprostasis, more or less digestive disturbance, and distention, occasionally pain and vomiting. If the condition is not relieved, strangulation may occur.

A *strangulated hernia* is one in which there is not only obstruction of the bowel, but also mechanical interference with the circulation. It is generally caused by pressure exerted at the neck of the hernia upon the mesenteric vessels and the intestinal wall. The veins are first compressed. This produces passive congestion and œdema of all the tissues. As this increases in extent more pressure is produced and the arteries become occluded. This gives rise to ischæmia, necrosis of the gut, perforation, the formation of a fecal abscess, and later, by its discharge on the surface of the body, an artificial anus. The process, however, rarely goes on to this point for the reason that a severe and rapidly progressive toxæmia develops which causes death often before perforation takes place. The symptoms of strangulated hernia may be local and general. The local symptoms are pain, tenderness, and often increase in the size of the hernial tumor. Not infrequently it happens that a hernia which has always been reducible suddenly becomes irreducible and painful. Under these conditions general symptoms quickly develop. There is more or less abdominal pain, with tenderness, nausea, and prostration. The temperature may be normal, subnormal, or slightly elevated. The pulse is increased in frequency and soon becomes irregular and extremely weak. Vomiting is the most constant symptom. It occurs early and is practically continuous. At first only the contents of the stomach are ejected ; later, bile and intestinal matter. There are distention and rigidity of the abdomen ; the bowels cannot be moved except from a point below the obstruction, and no flatus is expelled. The prostration increases, the face becomes pinched, the eyes sunken, the tongue dry, and the teeth covered with sordes. The mind wanders, the extremities become cold, and the entire body is bathed in cold perspiration. There is frequent involuntary regurgitation of fecal matter, and death may occur at an early period from exhaustion.

Inguinal Hernia.

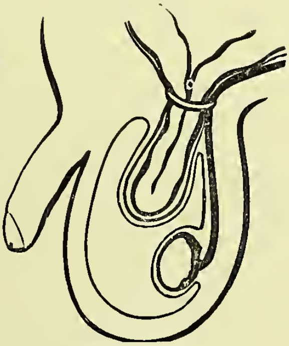
Inguinal hernia is the commonest form of rupture, 80 per cent. of all hernias occurring in this region. In this variety the protrusion takes place in the inguinal region, either obliquely by following the spermatic cord through the inguinal canal and external abdominal ring into the scrotum, or directly through the abdominal wall at Hesselbach's triangle and outward through the external ring, sometimes descending into the scrotum. The former, which is called *oblique inguinal hernia,* is by far the most frequent, comprising 93 per cent. of all inguinal ruptures. It occurs more frequently in males and is common in children. In a certain number of cases it appears shortly after birth, and in these the protrusion enters a preformed peritoneal pouch, the unobliterated vaginal process of the peritoneum. This variety is called *congenital inguinal hernia.* Occasionally the vaginal process is closed at its upper extremity only, leaving a large tunica vaginalis extending nearly to the internal abdominal ring. Into this an acquired hernial protrusion may occur, which invaginates the enlarged tunica and produces a peculiar variety called *infantile hernia,* in which the protruding viscus is surrounded by three layers of peritoneum. The term infantile hernia is also employed to describe any acquired hernia associated with a more or less patent funicular process. In the ordinary acquired variety of oblique inguinal hernia the protruding viscus in its descent through the inguinal canal pushes in front of it not only its own sac of peritoneum and fatty tissue, but also a process of the transversalis fascia and the cremasteric fascia. As it emerges from the external abdominal ring it enters the process of the intercolumnar fascia which incloses the cord, and finally descends into the scrotum, where it is covered by the dartos and skin (Fig. 369). This is the adult type of the disease. Figs. 366, 367, and 368 illustrate the peritoneal arrangement of the various kinds of oblique inguinal hernia.

Fig. 366.



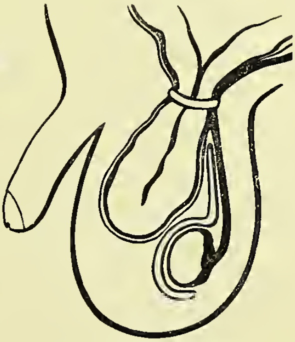
Congenital hernia.

Fig. 367.



Infantile hernia.

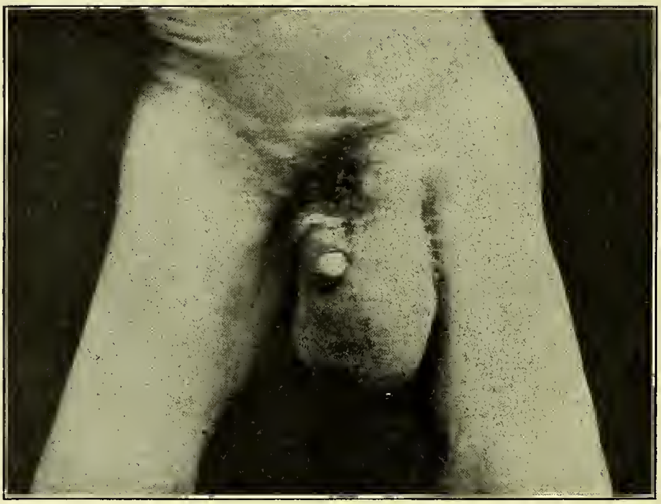
Fig. 368.



Acquired hernia.

In *direct inguinal* hernia, which is comparatively rare, the protrusion takes place through Hesselbach's triangle or that space in the lower abdominal wall bounded by the sheath of the rectus muscle, the deep epigastric artery, and Poupart's ligament. If the protrusion occurs in the outer half of this space, between the epigastric and obliterated hypogastric artery, the hernia will have practically the same coverings as an oblique inguinal hernia; if it occurs through the inner half of the space, it may carry with it a tunic made up of the denser portion of the transversalis fascia, with or without a few fibres of the conjoined tendon, or it may force its peritoneal and subperitoneal coverings beneath or between the fibres of this structure, and receive only an investment of the intercolumnar fascia. The classically described seven separate coverings of an inguinal hernia can seldom be recognized at operation or autopsy. The skin and superficial fascia are always present; also a number of more or less delicate and transparent tunics, one of which contains cremasteric fibres and another fatty tissue. In old and inflamed cases these tunics may be greatly thickened, and almost any number of layers may be demonstrated as a result of artificial dissection. In the oblique variety the sac lies in front of the spermatic cord, both being contained in a layer of fascia (cremasteric and intercolumnar); in the direct variety the sac generally lies behind or to the inner side of the cord, and the two may not be contained in the same fascial sheath.

Fig. 369.



Large left-sided inguinal hernia.

In both forms of inguinal hernia the cæcum or sigmoid may be present. If freely movable and attached to the abdominal wall by a mesentery, these differ in no respect from other ordinary forms of enterocele. If, however, the fixed portion of the cæcum or sigmoid occupies the hernial sac, the condition is spoken of as a *sliding hernia* or *hernie par glissement.* In these cases the sac is incomplete, and the bowel can only be returned to the abdominal cavity by a return of the sac, which is made up of the adjacent parietal peritoneum.

Hernia of the bladder occasionally occurs in inguinal ruptures. It may protrude within the sac, or it may lie wholly outside of the peritoneum by the side of the sac. The presence of a large amount of subserous cellular tissue to the inner side of the sac should suggest this possibility and lead the operator to dissect with care.

Symptoms.—Congenital hernia may be present at birth, may occur after birth suddenly as a result of some severe strain, or it may develop gradually as the adult variety. Acquired oblique inguinal hernia comes on slowly, first appearing as a slight fulness at the internal ring, which gradually becomes larger and distends the inguinal canal, and later passes through the external ring into the scrotum. When the protrusion occupies the inguinal canal it is called an incomplete hernia or *bubonocele.* When it reaches the bottom of the scrotum it is spoken of as complete or *scrotal hernia.* A scrotal hernia is pear-shaped, with the fundus downward. The neck can be traced obliquely upward and outward through the inguinal canal to the region of the internal ring. In old oblique hernias, however, the weight of the scrotal contents will often tend to draw the neck of the sac and internal ring toward the median line, and in these cases the axis of the hernial tumor may be vertical.

In direct inguinal hernia the cause is usually some sudden strain or severe exertion. In a few instances the hernia develops at the moment of greatest strain, and gives rise to a sudden sickening pain, and the occurrence of a tender oval tumor in the region of the external abdominal ring. This tumor gradually increases in size, but shows little tendency to force its way into the scrotum.

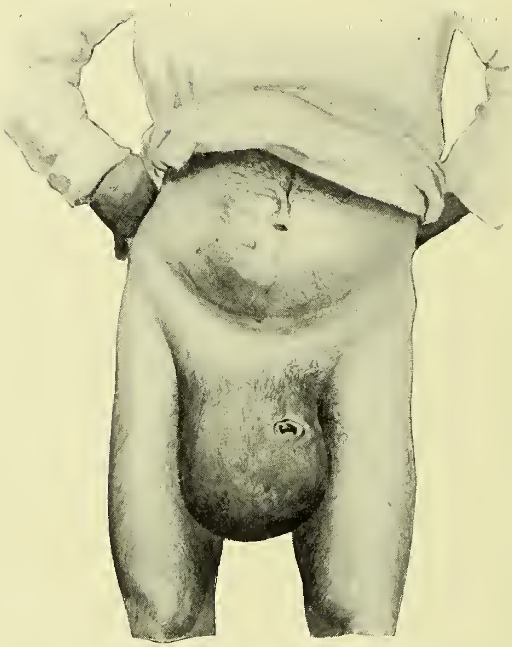
Pain may be absent throughout the entire course of a slowly developing hernia. Generally, however, pain is present, and is referred either to the region of the umbilicus or to the site of the rupture. There is often only a slight sense of discomfort or dragging; exceptionally the pain may be severe, and is accompanied by more or less grave digestive disturbances, and symptoms of neurasthenia. In the majority of cases there is also a sense of weakness in the inguinal region, and the patient instinctively supports the part with the hand during any unusual muscular effort.

The size of the scrotal tumor may vary from that of an almond to that of a large-sized egg-plant, or even larger (Fig. 370).

In many cases of small hernial protrusions the patient is unaware of the disease, and in a number of instances even of large ruptures the patients suffer so little discomfort that they go through life without ever seeking medical or surgical advice.

Diagnosis.—In oblique inguinal hernia there is a history of a slowly developing inguinal and scrotal tumor. The affected half of the scrotum is enlarged and pear-shaped, the fundus points downward, the apex upward and extends well into the inguinal canal toward the internal ring. The mass feels soft, is painless, and if it contains intestine is resonant on percussion. There is a distinct impulse on coughing, and, if the mass is reduced, there is a gurgling sound when the intestine is returned to the abdominal cavity. The neck of the sac lies to the outer side of the deep epigastric vessels.

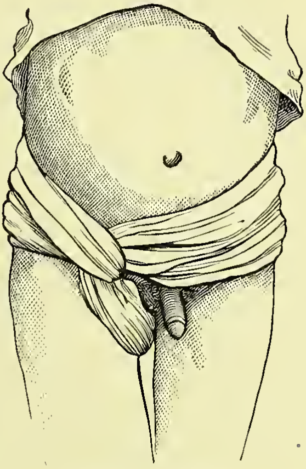
Fig. 370.



Large scrotal hernia. (Richardson.)

In direct inguinal hernia there is generally a history of a suddenly developed inguinal tumor following some severe exertion. It is rounded, and commonly occupies a position immediately over the external ring, and rarely descends into the scrotum. When it enters the scrotum its axis is vertical rather than oblique. It is often impossible before operation to distinguish a direct inguinal hernia from an old oblique rupture if the neck of the latter has been dragged toward the median line by the weight of the scrotal mass. The neck of a direct hernia is, however, always to the inner side of the deep epigastric vessels.

Fig. 371.



Worsted truss.

In the *differential diagnosis, inflammatory conditions* of the testicle or epididymis can be excluded by the absence of pain, tenderness, redness, and dense induration, by the presence of an impulse on coughing, by the shape of the mass, and by the fact that hernias can generally be reduced; *hydrocele* can be excluded by the absence of fluctuation and transparency, and by the presence of an impulse; *varicocele,* although it may have an impulse on coughing and may disappear on lying down, can be excluded by the absence of the peculiar worm-like masses in the scrotum which are pathognomonic of dilated veins. A bubonocele may rarely be mistaken for an *inguinal adenitis* or abscess; but if the little finger is passed into the inguinal canal by invaginating the scrotum, an impulse can generally be felt on coughing.

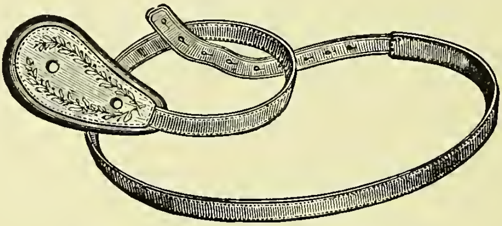
Treatment of Inguinal Hernia.—Inguinal hernia occurring in infants may be treated by the application of the worsted truss (Fig. 371), which is readily constructed from an ordinary skein of any soft elastic worsted, one part of which is made to encircle the body just above the iliac crests, the other joins this in front and behind and forms a perineal band. The worsted should be snugly applied, and the knot made by the junction of the two bands in front should be directly over the inguinal ring.

At a later age an ordinary spring truss (Fig. 372) may be used. From 50 to 60 per cent. of inguinal hernias in infants are said to be cured by the intelligent use of a truss. Adults are rarely cured by the truss treatment, and it should be advised only as a palliative measure. By its use, however, many of the discomforts and some of the dangers of the affection can be avoided. In oblique inguinal hernia the pad should be made to press directly over the internal ring; in the direct variety it should accurately cover the external ring. A truss should never be worn on an unreduced hernia or on a hernia which it will not hold in place, as in that case it would favor the development of strangulation. Under no circumstances should the pad rest upon the pubic bone.

There are, however, certain well-grounded objections to the truss treatment. In the first place, the use of a truss is always a source of discomfort to the patient, and, if improperly applied, often a source of positive danger; second, its prolonged use causes, in many cases, a well-marked pressure-atrophy of the lower border of the internal oblique muscle, diminishing thereby the chances of a radical cure by subsequent operation; and third, it practically never cures adults, and even in young children it fails in at least 40 per cent. of the cases.

In view of the uniform success which follows the radical treatment of inguinal hernia, operation should be advised in all individuals in whom there is present no disease or other condition to contraindicate the administration of an anæsthetic or the performance of a comparatively slight operation. While many surgeons prefer not to operate upon young children and advise waiting until the age of five or six years, Grossman[1] has recently published a series of 110 operations for hernia in young children—many of them under one year of age—with no mortality, no wound infection, and with an apparent cure in every instance. In advising operation in children one should be guided by the physical condition of the child rather than the age. In general, it may be stated that the truss should be avoided if the case is to receive operative treatment. The technic of the operative treatment and the management of strangulated hernias will be considered at the end of the chapter.

Fig. 372.



Spring truss.

Femoral Hernia.

This variety of hernia is less frequent than the inguinal, the proportion being about 1 of the femoral to 17 of the inguinal. It never occurs as a congenital affection, and is generally observed in adult females. The protrusion leaves the abdominal cavity at a point just beneath Poupart's ligament and to the inner side of the femoral vein. It enters a membranous pouch, called the *femoral canal*, which is the inner compartment of the femoral sheath. This canal extends downward by the side of the femoral vein to the saphenous opening of the fascia lata. In its descent the sac of the hernia carries before it a thickened pouch of the subserous cellular tissue, called the *septum crurale.* As it emerges at the saphenous opening it also receives an investment from the *cribriform fascia.* Recently developed femoral hernias may be covered only by the skin, superficial fascia, and a single layer of dense membrane, called by Cooper the *fascia propria,* which results from a fusion of the septum crurale and the cribriform fascia. In long-standing cases dissection will occasionally reveal several layers which are probably the result of an inflammatory process.[1]

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[1] "Münchener med. Wocenhschrift," May 12, 1908.

The neck of a femoral hernia is in relation anteriorly with Poupart's ligament, posteriorly with the pectineal fascia, externally with the femoral vein, internally with Gimbernat's ligament. In about 29 per cent. of the cases the obturator artery arises from the deep epigastric, and in the majority of these cases it passes beneath the femoral canal to the obturator foramen. In a small number of instances (1.5 per cent.) it passes over the canal and downward along the free edge of Gimbernat's ligament, and is in danger of being wounded if the constriction at the neck of the sac is incised for the relief of strangulation.

When the hernial protrusion emerges from the saphenous opening, it is directed upward and outward by the attachment of the cribriform fascia. This causes the tumor to overlie the ligament and to occupy a position at or near the site of an incomplete inguinal hernia, often rendering differential diagnosis difficult. The hernial tumor is generally small, and more often contains omentum than intestine. Occasionally the ovary, the Fallopian tube, the bladder, or the appendix will be found in the sac of a femoral hernia. Strangulation occurs relatively more often than in inguinal hernias. Not infrequently a portion only of the side wall of the gut is strangulated, a condition spoken of as *Richter's hernia.* In these cases total obstruction of the bowels may be absent. The same is true when the sac contains only a diverticulum from the intestine (*Littré's hernia*).

Symptoms.—A femoral hernia rarely gives rise to subjective symptoms until it becomes inflamed or strangulated. Exceptionally there is pain either locally or in the neighborhood of the umbilicus, and a sense of weight or dragging in the region of the groin. In the majority of instances the presence of a small oval tumor in the groin is the first sign of the disease. In corpulent individuals this often is overlooked, and the first indication of a hernia may be the symptoms of strangulation.

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[1] In a subject found in the dissecting-room of the College of Physicians and Surgeons, and used for several years as a demonstration preparation, a careful dissection by my then prosector, Dr. Harold C. Geyer, revealed the presence of seven apparently distinct layers of fascia.

Diagnosis.—The presence of a rounded swelling in the groin just below Poupart's ligament and to the inner side of the femoral vessels, which is resonant on percussion, which has a distinct impulse on coughing, and which can be reduced with a gurgling sound, may with certainty be diagnosticated femoral hernia. In the majority of cases, however, one or more of these signs are absent; thus in femoral epiploceles the tumor lacks resonance; in incarcerated hernias the impulse may be wanting; and in many others the tumor may rise above Poupart's ligament, and in fleshy individuals the exact position of the neck is difficult to appreciate.

Femoral adenitis may be excluded by the absence of impulse and resonance, and by the fact that the glandular mass is hard, often movable, frequently inflamed, and generally associated with other enlarged glands. A small single *lipomatous mass* is occasionally present in this region, and may closely resemble a small incarcerated epiplocele. Small lipomata may occasionally be present with a femoral hernia. *Psoas abscess* and *saphenous varix* may present an impulse on coughing and disappear on lying down; the former can generally be felt above the iliac fossa, and is associated with Pott's disease; the latter is commonly associated with varices of the lower leg.

Treatment.—Small reducible femoral hernias may be treated by a truss. They are, however, practically never cured by this treatment. The pad of the truss should be adjusted with care, and should insure closure of the femoral canal without producing pressure on the femoral vein.

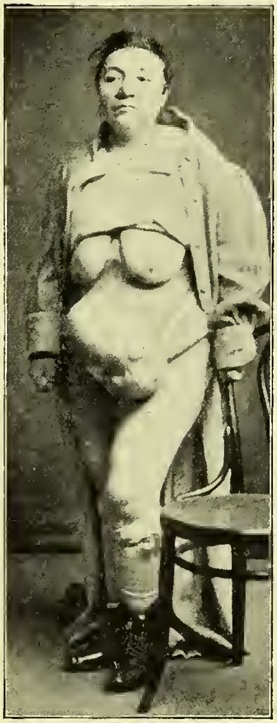
As the disease can generally be cured by a very simple operative procedure, and as this variety of hernia is particularly prone to strangulation, the radical treatment should be advised in all cases in which the general condition of the individual does not contraindicate operation.

Umbilical Hernia.

In this variety of rupture the protrusion occurs at the navel. The most frequent form is that which occurs in infants and young children. It is in reality simply a yielding of the umbilical cicatrix, due to incomplete closure of the mesoblastic layer, with intra-abdominal pressure from constipation, phimosis, or other conditions associated with straining efforts. This variety is small in size, and generally disappears spontaneously at or before puberty. The variety second in frequency and first in importance is the umbilical hernia of adults. It occurs generally in women, and most frequently after several pregnancies, which may result in a more or less well-marked separation of the recti muscles at the navel. The site of the protrusion is most commonly just above the umbilicus, although it may occur below it. The tumor is generally made up of a sac of peritoneum, which may or may not be covered with a fibrous tunic derived from the rectus sheath. In some cases the peritoneum is adherent to the skin, and both may become so attenuated that the peristaltic movements of the contained bowel may be distinctly seen. In many cases inflammatory adhesions are present between the bowel, the omentum, and the sac, preventing reduction and favoring strangulation. The hernial tumor may reach an enormous size and cause great disfigurement. A third and exceedingly rare form of umbilical hernia is the *congenital umbilical hernia.* This condition is due to an arrest of development, resulting in an imperfect union of the abdominal walls, which allows a portion of the intestine or other abdominal viscera to remain outside of the abdominal cavity,. in a pouch situated at the base of the umbilical cord. Occasionally strangulation is produced by the too low application of the ligature at birth.

Symptoms and Signs.—All of these varieties are so easily recognized by inspection that an extended description is unnecessary. In the infantile variety the navel appears rounded and somewhat bulging. It is larger in circumference than usual, and a distinct impulse is felt on coughing. The same is true in the earliest stage of the adult variety. These, however, increase in size slowly at first, more rapidly later, especially if additional pregnancies follow. They may reach the size of a cocoanut, or even an adult head (Fig. 373).

Fig. 373.



Large umbilical hernia. (Roberts.)

When at rest such a hernia appears as a flaccid abdominal appendage ; as soon as the abdominal muscles are contracted the tumor becomes erect and tense. In these cases more or less pain may be present, especially on severe exertion. There is, in addition, a feeling of weakness and lack of proper support. Digestive disturbances and constipation are frequent.

Treatment.—The small protruding navels of infants and young children should be treated with a pad and adhesive straps. Those of moderate size occurring in adults may be treated in the same manner. The use of the elastic abdominal belt gives great comfort in the more severe cases which, for any reason, are not suitable for operation.

If the hernia is large and causes much discomfort, if it is irreducible, and especially if any symptoms suggesting strangulation have occurred, operative treatment is to be advised, although one cannot give the same assurance of permanent success as in the inguinal and femoral varieties.

Ventral Hernia.

Ventral hernia is an abdominal protrusion occurring at some point other than the navel or groin. These hernias occur most frequently from the yielding of scars of operative wounds, and are therefore most commonly found in the median line, over the appendix or gall-bladder, over the sigmoid or in the lumbar regions. Diastasis of the recti from any cause above or below the umbilicus is an etiologic factor second in point of frequency, and small fatty hernias of the linea alba above the navel may by dragging on the peritoneum give rise to secondary visceral hernias in this region.

The great majority of these ruptures are similar in character and general behavior to the adult umbilical hernias just described. In a small number of cases which follow abdominal wounds and which have healed by granulation only a thin layer of skin or scar-tissue covers the protruding viscera. These rarely become strangulated, on account of the extensive adhesions which are generally present.

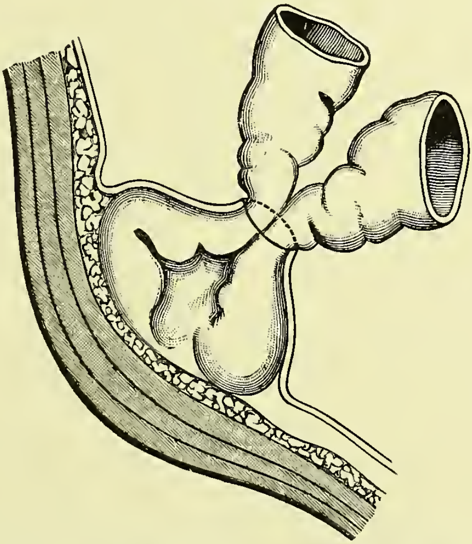
Diagnosis.—This presents no difficulties in the majority of cases, and can be made by inspection and palpation, the usual features of a hernia being present in all but one variety, the small *fatty hernias of the linea alba.* As these consist simply in the protrusion of a small knuckle of fat from the subserous fatty tissue through a small opening in the linea alba, the only symptoms may be a painful point in the median line and the presence of a small tender nodule. There is little or no impulse at first, and the tumor is often exceedingly small.

The **treatment** of ventral hernia is the same as for the umbilical variety. The operative procedures will be considered at the end of the chapter.

RARE FORMS OF HERNIA.

Interstitial Hernia.—This is a form of hernia in which the protruded mass in its descent does not follow the direction of an ordinary inguinal hernia, but spreads out between the peritoneum and the transversalis fascia (*properitoneal hernia*), between the internal and external oblique muscles, or between the external oblique aponeurosis and the skin. Occasionally two distinct but communicating sacs are present, one entering the scrotum in the usual manner and the other in one of the abnormal situations just described. In many cases of the first or deeper-seated variety no tumor is present, and exact diagnosis is often impossible before operation. The third variety is often associated with undescended testicle and a contracted state of the scrotum. Occasionally a properitoneal hernia is produced by the apparent reduction of an incarcerated inguinal or femoral hernia, the so-called reduction *en bloc*, the entire sac and its contents being pushed backward through the ring between the muscles and parietal peritoneum, where it remains still constricted by the neck of the peritoneal sac.

Fig. 374.



Properitoneal hernia. This illustrates also incomplete reduction of hernia. (Richardson).

Diaphragmatic Hernia.—A protrusion of the intestine may rarely take place through the diaphragm into the cavity of the thorax. The weak areas in the diaphragm are in front, between the chondral and ensiform fibres, and behind, near the external arcuate ligaments. Congenital malformations and traumata may also give rise to diaphragmatic openings, through which a hernia may protrude.

Lumbar Hernia.—A rare form of ventral hernia in which the protrusion occurs in Petit's triangle, between the external oblique and the latissimus dorsi muscle just above the iliac crest, below the twelfth rib, or through one of the vascular foramina of the lumbar aponeurosis.

Obturator Hernia.—An exceedingly rare hernial protrusion through the obturator foramen, along the course of the obturator vessels and nerves. A tumor or fulness appears in Scarpa's triangle well to the inner side of the femoral vessels, and pain is present along the course of the obturator nerve.

Sciatic Hernia.—In this variety the protrusion occurs below the pyriformis muscle through the great sacrosciatic foramen, and causes an external tumor beneath the gluteal muscles.

A protrusion may occur above the pyriformis muscle, and is called **gluteal hernia.** Hernias are also described as occurring in the perineal region, the ischiorectal fossa, or into the vagina, but these are so rare as to be regarded simply as surgical curiosities.

THE RADICAL OR OPERATIVE TREATMENT OF HERNIA.

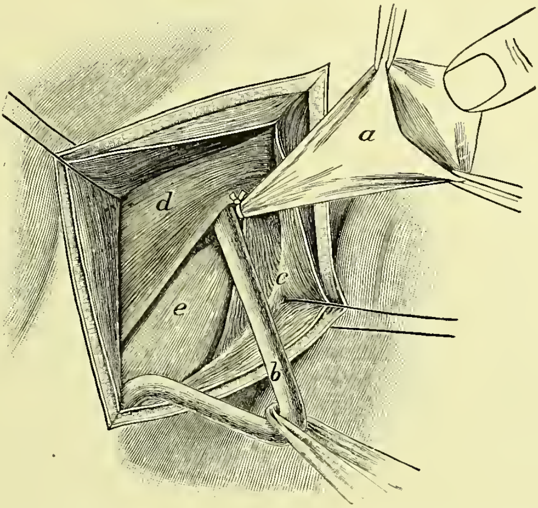
Many operations have been devised for the radical cure of inguinal and other forms of hernia, but it is only since the publication of the successes obtained by Bassini and Halsted that the profession has acquired much faith in their lasting results.

Operations for Inguinal Hernia.

The **Bassini operation** is performed as follows: An incision is made over the inguinal canal parallel with Poupart's ligament, extending from a point just above and to the outer side of the internal ring to a point one inch below and to the inner side of the spine of the pubis.

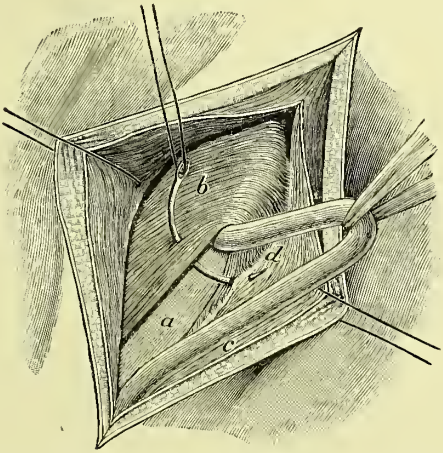
The structures are divided down to the aponeurosis of the external oblique muscle and the external ring exposed. A director is then passed into the canal from the external ring and the aponeurosis split in the direction of its fibres to the upper limit of the incision. The lower flap thus formed is everted and the structures separated from its inner surface, freely exposing Poupart's

FIG. 375.



Operation for the radical cure of inguinal hernia (Bassini's method): *a*, sac dissected from the cord, opened, examined, and neck ligated; *b*, cord; *c*, Poupart's ligament; *d*, arched fibres of internal oblique muscle; *e*, transversalis fascia. (Bryant.)

FIG. 376.



Operation for the radical cure of inguinal hernia (Bassini's method): sac removed (*c*), cord drawn aside, and stitching of lower fibres of the internal oblique and transversalis muscles (*b*) to Poupart's ligament (*d*) from without inward; *a*, transversalis fascia. (Bryant.)

ligament. The contents of the inguinal canal, consisting of the spermatic cord and the sac of the hernia, are then separated by division and removal of the various tunics, and the cord is retracted. After the sac is freed from the surrounding tissues it is opened and exposed to insure its emptiness, its neck drawn outward and securely ligated with a transfixion suture of catgut, the distal portion removed, and the stump allowed to sink into the abdominal cavity. Several deep sutures of kangaroo-tendon or chromicized catgut are then passed through the lower border of the internal oblique muscle and the thickened portion of Poupart's ligament, which is exposed by everting the inferior flap

FIG. 377.

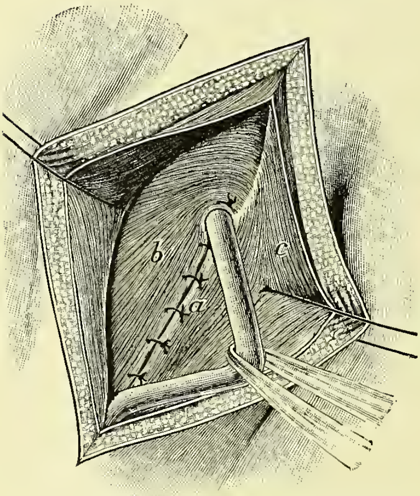


FIG. 378.

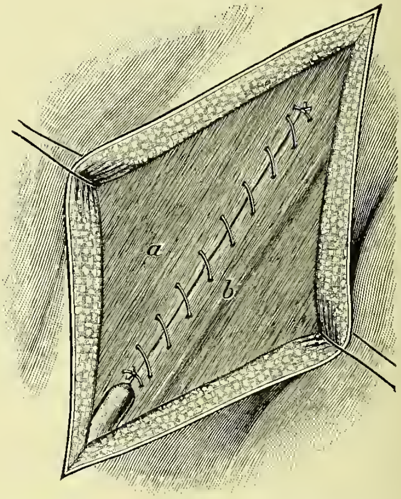
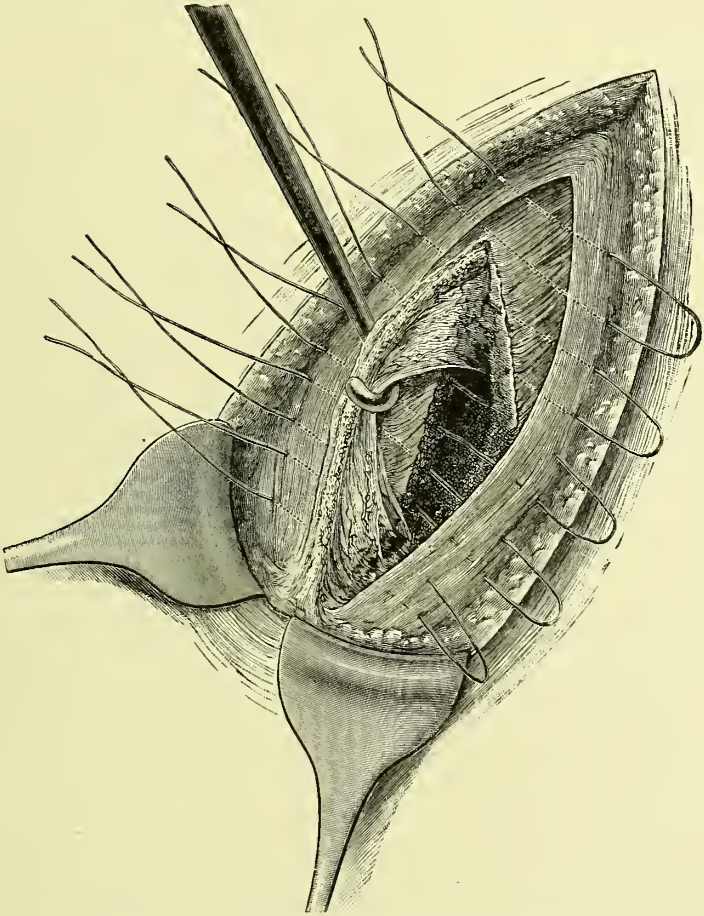


FIG. 244.—Operation for the radical cure of inguinal hernia (Bassini's method): arched muscular fibres and conjoined tendon (*b*) sewed to Poupart's ligament (*a*); *c*, aponeurosis of external oblique muscle. (Bryant.)

FIG. 245.—Operation for the radical cure of inguinal hernia (Bassini's method): aponeurosis of external oblique (*a*) sewed with continuous sutures to Poupart's ligament (*b*). (Bryant.)

of the aponeurosis of the external oblique. During the introduction of these sutures the cord is retracted. After the structures are snugly drawn together and the sutures knotted, reconstructing the floor of the inguinal canal, the cord is allowed to drop into place, and the roof of the canal is made by uniting the divided external oblique aponeurosis. This is accomplished best by a continuous suture of fine catgut, which should be carried down to a point which leaves only enough of the external ring open to allow the cord to pass outward without constriction (Figs. 375, 376, 377, and 378). The skin wound is then closed and the dressing applied. Bull and Coley have occasionally modified this technic by allowing the cord to remain beneath the deep layer of sutures uniting the internal oblique muscle to Poupart's ligament, emerging at the external ring. Adult patients should remain in bed from three to four weeks; children under fourteen years of age, from two to three weeks.

FIG. 379.

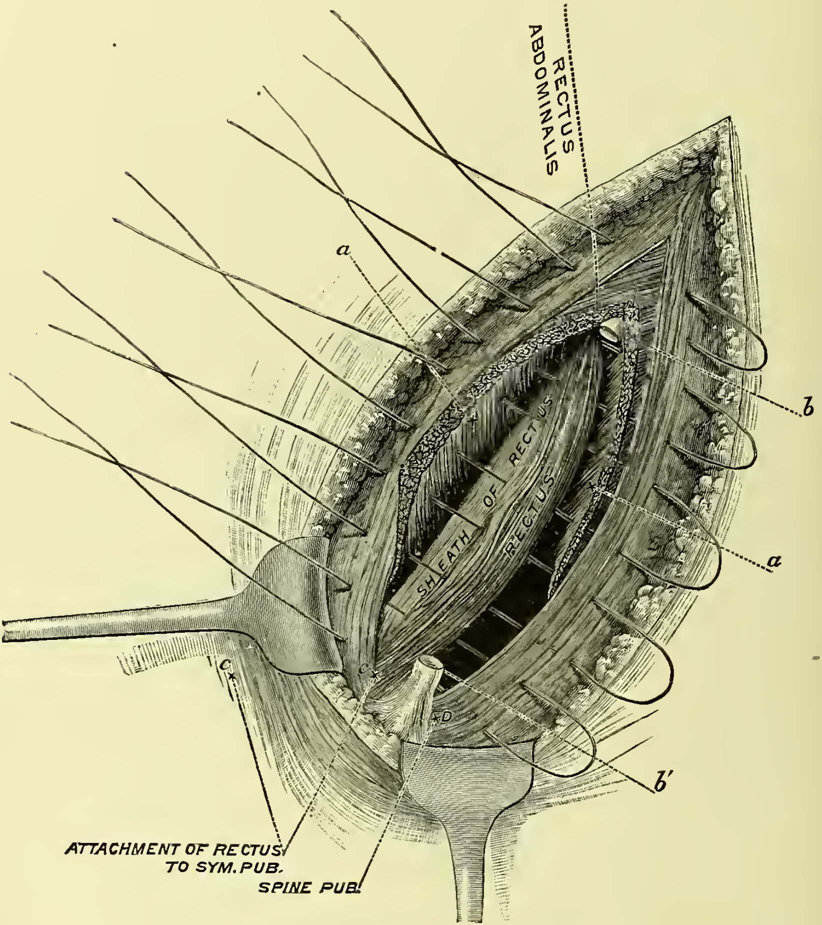


Operation for the radical cure of inguinal hernia (Halsted's method): veins ligated and resected; silver sutures inserted, one above and four below the cord. (Bryant.)

The operation is applicable to both varieties of inguinal hernia. Bull and Coley report 1185 operations, with 5 deaths and 9 relapses.

Halsted's operation differs from the Bassini procedure in that he divides the fibres of the internal oblique above the internal ring, draws the cord outward at the upper angle of the wound, unites all the deeper tissues, fascia, muscle, and aponeuroses to Poupart's ligament by a single row of mattress sutures of silver

Fig. 380.



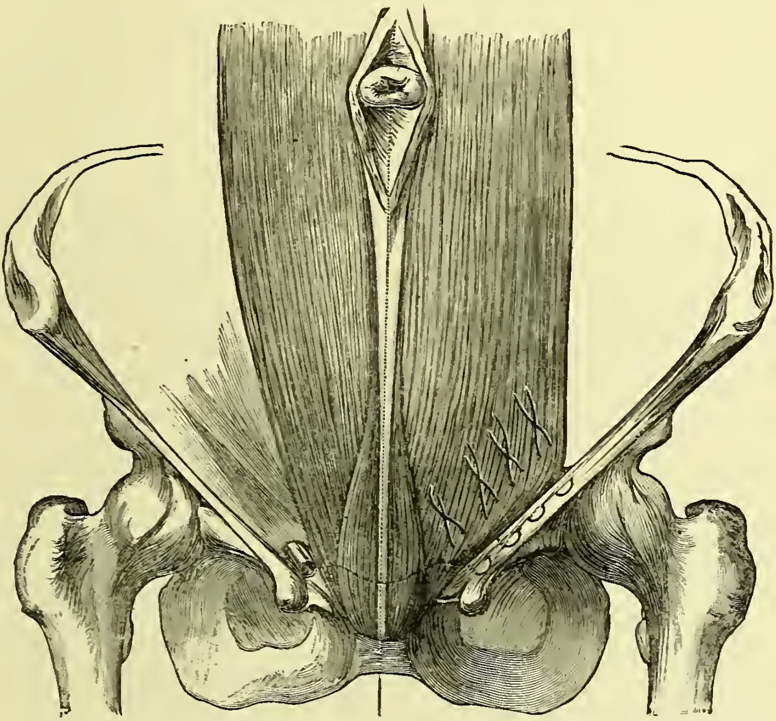
Operation for the radical cure of inguinal hernia (Bloodgood's modification of Halsted's method); cord removed so as not to obscure demonstration : *a*, *a*, divided borders of internal oblique muscle; *b*, *b*′, ends of resected cord. (Bryant.)

wire; removes the superficial veins of the cord, and allows it to pass from the upper angle of the wound to the scrotum between the muscles and the skin (Fig. 379).

Bloodgood's operation is a modification of Halsted's, and consists in exposing the outer fibres of the rectus muscle by a division of the posterior layer of the sheath, and including it in the lower three or four deep sutures, thus reinforcing the often thin and weakened fibres of the internal oblique muscle (Figs. 380 and 381.)

Blake sutures the rectus to Poupart's ligament in direct hernias with large openings, but employs separate sutures, and afterward brings the internal oblique down in front and sutures it as in the Bassini operation.

FIG. 381.



Operation for the radical cure of inguinal hernia (Bloodgood's modification of Halsted's method): the transplanted border of the rectus united to Poupart's ligament, showing slight change in the direction of its fibres. (Bryant.)

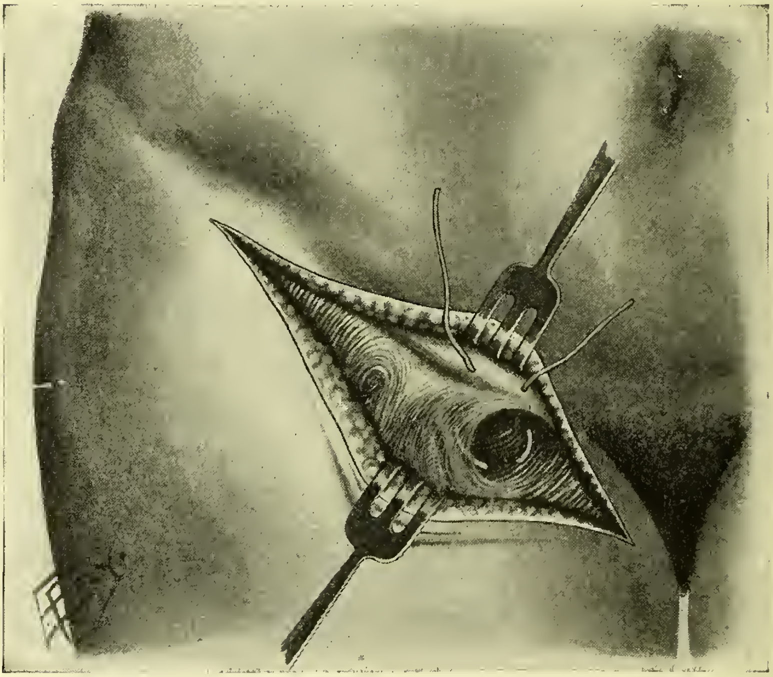
Kocher empties the sac and separates it from the cord as high as the internal ring, without dividing the aponeurosis. He then incises the aponeurosis near the internal ring, and by a pair of long-pointed forceps draws the sac outward and imbeds it, by a series of Lembert sutures, into a fold of the aponeurosis.

Operations for Femoral Hernia.

A large number of femoral hernias are cured by the simple operation of herniotomy for the relief of strangulation.

If after the bowel is returned to the abdominal cavity the sac is separated, ligated, and cut off, the femoral canal emptied by pushing the stump of the sac well backward into the abdominal cavity, and its walls approximated by almost any kind of suture, recovery will be likely to follow. This fact apparently has been overlooked by many surgeons who have devised more or less complicated and difficult operations which have for their object obliteration of the femoral canal by transplantation of muscle or by means of some plastic operation from above. These procedures are objectionable, in that they are technically difficult, often necessitate the opening of an intact inguinal canal, and are wholly unnecessary; for Coley has recently reported a series of 125 operations by the simple purse-string suture without a single relapse, more than half of his cases having already passed the two-year limit. As the statistics of the Hospital for the Rupture and Crippled show that practically

Fig. 382.



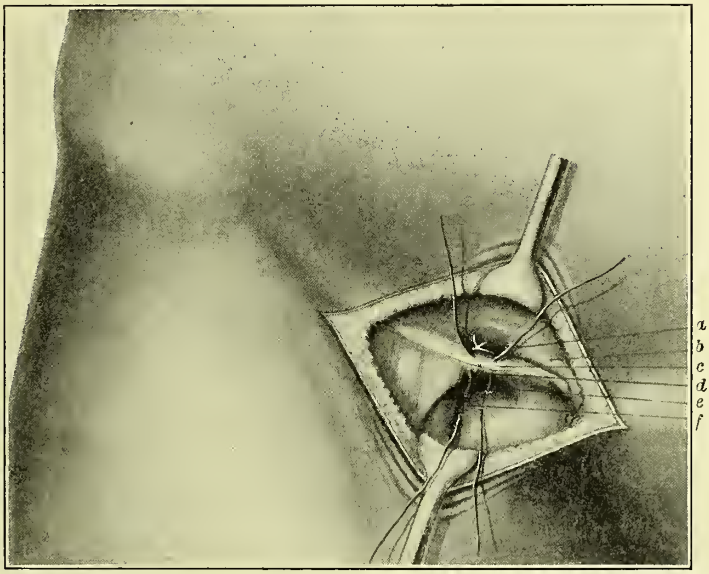
Obliteration of the femoral opening by purse-string suture. (Coley.)

90 per cent. of relapses after operations upon all varieties of hernia occur within the first year, there seems to be no reason for employing the more complicated methods. Several methods of approximating the walls of the femoral canal are in general use.

The **Cushing purse-string method** consists simply in the introduction of a purse-string suture of chromicized catgut around the margin of the saphenous opening. The needle is introduced through the inner portion of Poupart's ligament, then through the pectineal fascia, then passed upward along the inner border of the femoral vein, and outward near the original point of entrance. When this is drawn tight and knotted the lower portion of the canal is obliterated (Fig. 382).

The **Blake operation** has for its object the obliteration of the upper portion of the canal. A mattress suture is passed from above Poupart's ligament downward through Cooper's ligament and out of the lower opening of the canal, then upward near the margin of the femoral vein, through the same structures and emerging again above Poupart's ligament. When this structure is tied the upper extremity of the canal is closed. The lower margin of the canal can then be united to the pectineal fascia by a few interrupted sutures (Fig. 383).

Fig. 383.

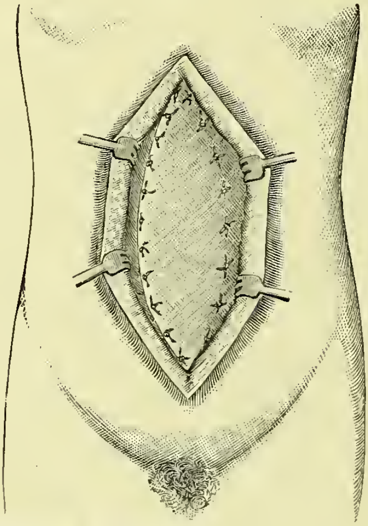


Blake's operation for femoral hernia. Mattress stitch in place and tied. Stitches to close lower opening of femoral canal inserted, but not tied. *a*, Mattress stitch; *b*, round ligament; *c*, Poupart's ligament; *d*, falciform process; *e*, fascia of pectineus; *f*, femoral vein.

Operations for Umbilical and Ventral Hernias.

The simplest operation for the relief of any of the ordinary forms of ventral hernia, whether occurring at the umbilicus or in any other part of the abdominal wall, is to expose the sac, empty it of its contents, and excise the redundant tissue. Next expose the various layers of fascia, muscle, and aponeurosis, and unite them with three layers of sutures: the first of catgut, closing the peritoneum; the second, of chromicized catgut, uniting the freshened muscular and aponeurotic layers: the third, of silkworm gut or silver wire, closing the cutaneous wound.

Fig. 384.



Blake's operation for the radical cure of umbilical hernia.

If union takes place without infection, this method succeeds in the majority of instances in which the rupture is of moderate size. In the large umbilical hernias and those due to an extensive diastasis of the rectus muscle relapses are frequent, and have led to the employment of other methods.

Blake, Mayo, and a number of other surgeons have employed a method which consists in removal of a large area of skin and subcutaneous fat, and the overlapping of the muscular and aponeurotic layers.

Blake's method consists in a large elliptical skin incision, removal of the subcutaneous fat, and exposure of a large area of the aponeurosis. The sac is treated in the usual manner with suture of the peritoneum. He then divides the linea alba to the upper and lower limits of the skin incision, separates the peritoneum from the abdominal wall on one side, and draws the muscular and aponeurotic flap thus freed from peritoneum over the opposite rectus muscle and secures it by two rows of chromicized mattress sutures, the first uniting the free border of the overlapped flap to the overlapping wall, by through-and-through sutures; the second, uniting the free border of the superficial flap to the deeper wall by sutures which do not penetrate the peritoneal cavity (Fig. 384). The cutaneous wound is then closed without drainage.

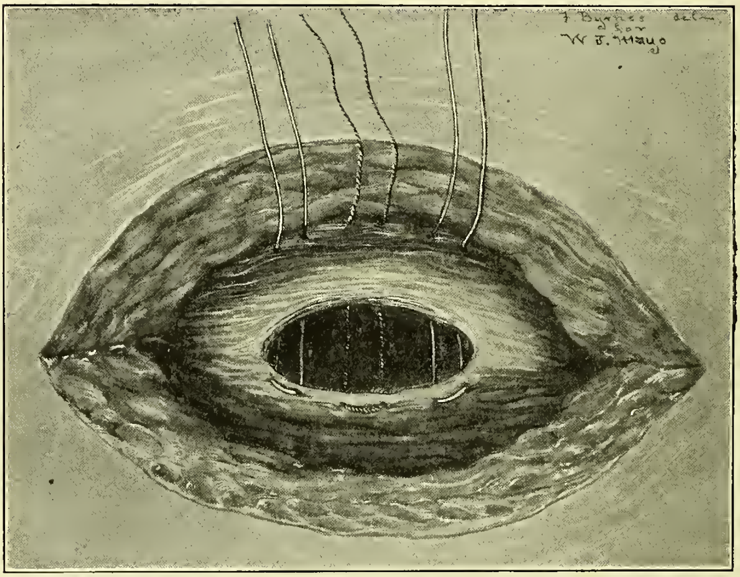
Mayo's operation is practically the same procedure carried out in a transverse direction, overlapping the aponeurotic septum between the two widely separated rectus muscles. In both of these procedures it is often difficult to separate the parietal peritoneum from the superficial layers, particularly when there is an extensive diastasis of the muscles, and the peritoneum is firmly adherent to the aponeurosis. In these cases it is not necessary to close the peritoneum separately, but simply to overlap the combined flaps, which consist of peritoneum, muscle, and aponeurosis in the manner already described. Figs. 385 and 386 represent the method of applying the sutures in Mayo's operation where the peritoneum remains adherent.

Other methods of closing large hernial gaps in the muscular and aponeurotic structures are by the use of a lattice-work of silver-wire sutures as suggested by Witzel and Phelps, or the use of a silver-wire netting or filagree, as practised by Göpel and Willy Meyer.

Operation for the Relief of Strangulated Hernia.

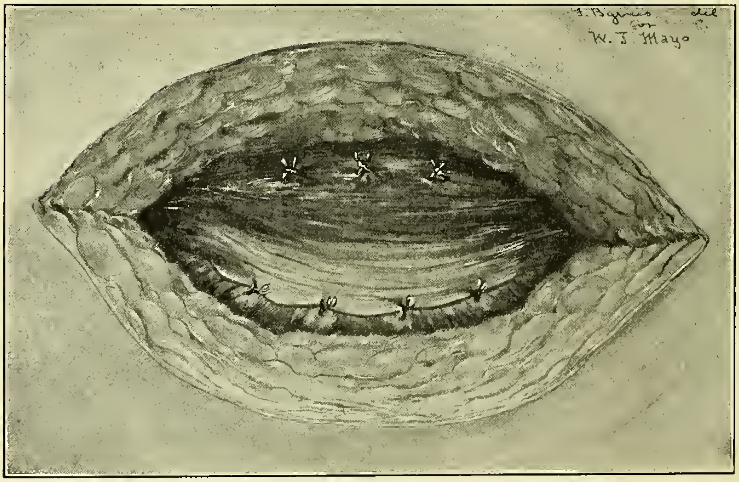
The operation for the relief of strangulated hernia should consist in an incision over the hernial tumor with careful dissection of the various layers until the sac is reached. This should be freely opened and its contents examined. If the bowel is black and lustreless, gangrene is already present, and the necrotic loop must be sacrificed; if of a dark, chocolate color, but retaining its lustre, it may be restored by relief of the strangulation; if simply congested, it can probably be saved if necrosis has not occurred at the point of constriction. The next step is to locate the ring of tissue which constricts the bowel, and to divide it, either from within by means of a small blunt-pointed hernia-knife, or preferably by careful dissection from without, freely dividing all the overlying tissues. When the constriction is relieved, the bowel should be drawn well downward into the wound, irrigated with hot salt solution, both arms carefully inspected and wrapped in hot compresses. A rapid return of the circulation, which includes

FIG. 385.



Suture of the aponeurotic and peritoneal structures, sutures placed. (Mayo.)

FIG. 386.



Sutured aponeurotic and peritoneal structures. (Mayo.)

the constricted area, justifies its return to the abdominal cavity and closure of the wound. If the viability of the gut is questionable, it may be wrapped in sterile gauze, and remain temporarily exposed in the wound, where it can be frequently inspected and returned when danger of necrosis is past; or, as suggested by Lilienthal, it may be returned to the abdominal cavity, but anchored near the open wound by a piece of sterile rubber band passed through the adjacent healthy mesentery, and if symptoms appear it may again be withdrawn and resected if necessary. In a hopelessly gangrenous bowel immediate resection and end-to-end anastomosis is the method of choice. If the condition of the patient is such as to preclude the possibility of this procedure, the bowel should be secured with two or three sutures, freely opened, and the wound dressed with sterile gauze, leaving for a subsequent operation removal of the gangrenous area and anastomosis.

Lilienthal has recently called attention to the fact that a hernial sac may contain two loops of apparently viable intestine, while the connecting arm may be gangrenous, but concealed within the peritoneal cavity. It should also be remembered that a properitoneal hernia may occur in connection with an inguinal or femoral rupture, and that both may be strangulated. Moschcowitz has shown that strangulation may occur in the scrotum, the constricting ring being near the testicle, at a point of incomplete closure of the sac of a congenital hernia.

Gangrenous masses of omentum should be removed after ligation with chromicized catgut.

In many cases the operation for radical cure may be performed immediately after the relief of a strangulated hernia.

CHAPTER XXX.

AMPUTATIONS.

GENERAL CONSIDERATIONS.

THE number of pathologic conditions requiring removal of a portion of a limb, or even an entire extremity, is so great that it has seemed wise to devote a chapter to the various operations employed for this purpose.

In performing an amputation the surgeon should always bear in mind that the object of the operation is not only to remove a hopelessly injured or diseased member, but also to accomplish this end with the smallest possible loss of tissue, with the minimum of risk to life, and to provide a stump which shall be well covered, painless, and capable of supporting an artificial limb if this be required.

The mortality which attends an operation for the removal of a limb is increased with its nearness to the trunk. The immediate danger is from shock; the remote danger, from sepsis and secondary hemorrhage.

In acute traumatic cases the patient is often already in a condition of extreme shock, which, if the shock of operation be added, might immediately prove fatal. In cases of grave sepsis from acute osteomyelitis and other conditions requiring amputation the patient is also in a poor condition to resist the shock of operation. Under these circumstances operation should, if possible, be delayed until the patient has in a measure recovered from shock, or until the extensive toxæmia from his septic infection has been temporarily relieved. It frequently happens, however, that the nature of the injury or the progress of the septic infection is such as to preclude the possibility of delay. Under these circumstances speed of operation, and the minimum of anæsthesia and exposure on the operating-table, are the factors which bring success.

While one should never become careless in his aseptic technic, in hopelessly infected cases requiring major amputations, in which there is present also a condition of shock or severe sepsis, to devote five or ten minutes to the preparation of the operation field, after the patient is under the influence of the anæsthetic, is but to invite disaster. The patient is much more likely to recover from an infection in a well-drained wound than from severe operative shock. In hip-joint and other major operations undertaken under conditions of this kind, the writer has been in the habit of adopting the following plan :

On the day before the operation the patient is given a cathartic and a large amount of water to insure free action of the bowels and kidneys. The operative field is thoroughly prepared and covered with a wet bichloride dressing. One hour before operation he is given $\frac{1}{4}$ grain morphine and $\frac{1}{100}$ grain scopalamine subcutaneously ; half an hour later, $\frac{1}{20}$ of a grain of strychnine ; fifteen minutes later, an enema of 8 ounces of hot coffee, which is retained in the bowel until he is brought to the operating-table. On the operating-table the patient is placed in the position he will occupy during the amputation, the limb is held by an assistant, and the dressings freely exposed and ready to be cut. Ether or chloroform[1] is then administered, and if the patient is thoroughly under the influence of the morphine, only a very small amount is necessary to bring about rapid surgical anæsthesia. The moment the anæsthetist reports the patient ready, the dressings are quickly removed, the tourniquet applied, and operation performed without delay. Twelve or fifteen minutes is all that is necessary for any ordinary operation carried out in this manner. If the patient shows signs of collapse, an intravenous infusion should be administered during the performance of the operation by an assistant detailed for that purpose.

Under all other conditions amputations should be carried out with sufficient deliberation to insure the construction of well-fitting flaps so fashioned as to be abundantly supplied with blood and of such a length as properly to cover the bone without tension. The most scrupulous care should be taken to insure asepsis in clean cases, and thorough antisepsis and adequate drainage in infected cases, for infection of an amputation-stump not only greatly delays recovery, but also furnishes added danger to the operation in that it may cause extensive cellulitis, osteomyelitis, gangrene, and secondary hemorrhage, any one of which may prove fatal.

Hæmostasis.

In all the major amputations it is desirable to prevent unnecessary loss of blood during the operation by the application of a tourniquet to the limb well above the operative field, in such a position that it will compress the main arterial trunk. For this purpose the old-fashioned Petit's tourniquet may be employed, or simply a firm India-rubber tube drawn tightly about the limb and tied or held with forceps. The author's solid rubber tourniquet with metal clasp (Fig. 387) is perhaps the easiest to apply and to loosen.

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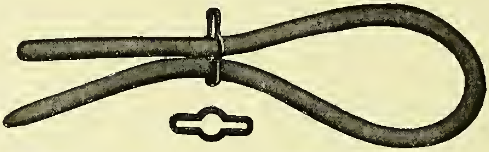
[1] The writer prefers chloroform in alcoholic subjects, for the reason that in these cases the administration of ether is often attended with considerable delay and exhausting struggling which greatly diminishes the resistance to shock.

Bloodless amputations can be secured by the application of the Esmarch rubber bandage from the extremity of the limb to the point of application of the tourniquet. To be effective, it should be snugly applied, and after its removal the limb should be blanched and remain so until the tourniquet is removed. The disadvantages of this method are that there is always a reactionary congestion of the limb, which occurs after the tourniquet is removed, and which leads to troublesome oozing and the necessity for many ligatures. Elevation of the limb for thirty or forty seconds before the application of the tourniquet will prevent troublesome venous hemorrhage, and is the method usually employed.

Fig. 387



Author's solid rubber tourniquet with metal clasp.

As soon as the distal portion of the limb is removed, the larger vessels should be found, drawn outward, separated from each other and the nerve-trunks, and securely ligated, after which the tourniquet should be loosened and the smaller vessels clamped and tied.

Method of Making the Flaps.

Flaps are made of skin, which should always include the subcutaneous areolar tissue; of skin and muscle; of skin, muscle, and periosteum; or the flap may contain also a portion of adherent bone (osteoplastic amputations).

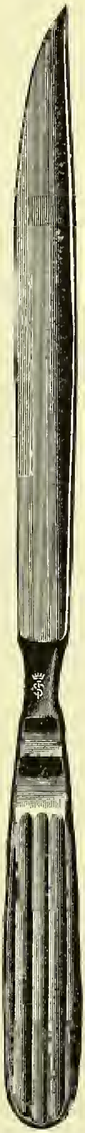
Skin flaps are made by cutting from without inward with a large scalpel. The flap is generally first marked out, and should be as broad at the extremity as at the base; otherwise the normal retraction of the tissue will result in the formation of a conical flap which can be made to cover the muscular and bony stump only with difficulty. In raising the flap the blade of the scalpel should be directed toward the muscle, to insure freedom from injury of the subcutaneous vessels. When the flap is to be composed of skin and muscle, it can be made by transfixion, or by the method of skin dissection from without, as just described.

In the method by transfixion the left hand of the operator grasps and raises the fleshy part of the limb above the bone. A long-bladed amputating-knife (Fig. 388) is then passed transversely through the limb above the bone, and by a sawing motion an oval flap is made, the apex of which is directed downward. The knife is then reintroduced below the bone and a similar flap cut from the inferior aspect of the limb. These are then retracted, the bone sawn through, and the distal portion removed. If the flap is made by cutting from without, the skin is first incised and dissected backward for about an inch, the muscles are then divided down to the bone on either side, and separated from it by blunt dissection; or, after the skin is retracted, the muscles may be divided by transfixion, care being taken to insure the muscular part of the flap being smaller in extent than its cutaneous covering.

If the flap is to contain periosteum, it should be separated from the bone, but not from the muscle, and should be of such a shape that it will fall over and cover the cut extremity of the shaft when the flaps are sutured in place. Periosteal flaps, unless made in this manner, are worse than useless, because they generally leave a portion of the bone exposed, and therefore favor necrosis. It is better to follow the advice of Bryant, and saw the bone without disturbing the periosteum.

In osteoplastic amputations the object is to cover the open extremity of the shaft by a thin section cut from a neighboring bone, which retains its connection with one of the flaps. The results of this operation at the ankle and at the knee-joint have been so satisfactory that Bier and others have sought to apply it to amputations in other localities; and while it undoubtedly gives a better bearing stump when the plan can be successfully carried out, the technical difficulties in situations in which the protecting bone flap has to be sawn from the shaft of a long bone are so great that the procedure has not as yet been generally adopted.

Fig. 388.

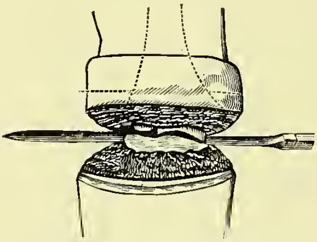


Long-bladed amputating-knife.

The Circular Method.

This method is chiefly applicable to the thigh and arm, but it may be used also in the leg and forearm. It is carried out in the following manner : A circular incision is made through the skin and subcutaneous tissue at a distance not less than one-fourth of the circumference of the limb, from the point of division of the bone (Bryant). This is made best by a long-bladed amputating-knife, and the integument dissected from the deep fascia and muscles and turned upward as a cuff. An assistant then draws the tissues well upward, and the surgeon makes a second circular incision around the limb, this time dividing the superficial layer of muscles. A third section is then made, after further retraction of the soft parts by the assistant, dividing the deeper muscular layer to the bone. The soft parts are then drawn well away from the bone by a two-tailed muslin retractor, and the bone sawn through and the sharp edges rounded off by the rongeur. This leaves a funnel-shaped hood of soft tissue, which falls over the bone, and may be united with a few deep catgut sutures drawing the muscles together, and a row of silk or silk-worm gut sutures for the skin (Fig. 389).

Fig. 389.



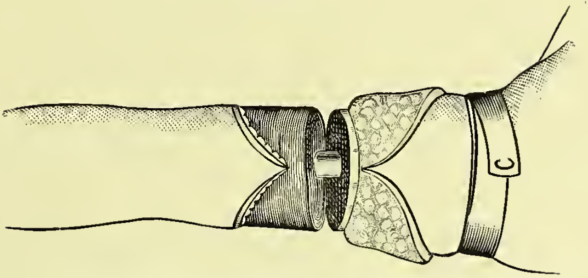
Amputation through elbow-joint by circular method. (Smith.)

Several modifications of this method are in use—one in which the muscles are divided by a single cut at the base of a long cutaneous cuff, another in which one or more vertical incisions are made in the skin flap with more or less rounding of the edges (Liston).

Skin-flap Method.

In this method two equal or unequal flaps are made of skin and fascia. These may be an anterior and a posterior one ; or two lateral flaps, each of which should be rectangular in shape, with the distal corners rounded. In cutting these flaps, one should estimate the combined length to be not less than one and a half, and often two, diameters of the limb at the point of bone section. The flaps are dissected free from the muscles and retracted, after which the muscles may be divided to the bone by a circular incision at the base of the skin flaps (Fig. 390). In case it happens that the injury or disease for which the amputation is undertaken is situated on one side only of the limb, practically the entire flap may be raised from the opposite side. Care should

FIG. 390.



Modified circular amputation: skin flaps and circular incision through muscles. (Esmarch.)

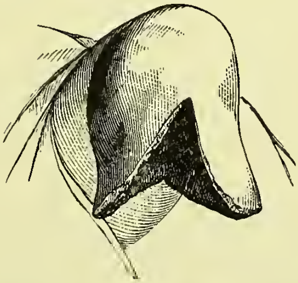
always be taken, however, in these cases to include the deep fascia in the flap, on account of the increased blood-supply thus obtained.

Skin- and Muscle-flap Method.

In this method two flaps are made, consisting of skin and muscle. These may be of equal or unequal length, and are generally made by transfixion from within outward, or by dissecting them from without inward as described above.

It is a quick and easy method, and is chiefly applicable to the thigh, arm, or fleshy part of the forearm or leg. After the flaps are cut they should be retracted with a two- or three-tailed muslin retractor and the bones sawn, after which the muscles should be brought together with several buried sutures of heavy catgut, and the skin united in the usual manner.

FIG. 391.



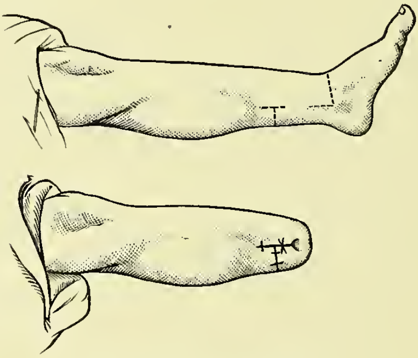
Amputation by lateral flaps. (Roberts.)

Lateral skin and muscle flaps, so fashioned that the incision reaches a higher point behind than in front, are advocated by Stephen Smith and others on the ground of better drainage and the fact that retraction of the scar eventually brings the cicatrix behind and out of the way of pressure by an artificial limb (Fig. 391).

Teale's Method.

This method is applicable chiefly to the leg and forearm, and should consist in a long anterior flap of skin and muscle, and a short posterior flap similarly constructed. The length of the anterior flap should be one-half the circumference of the limb at the point of bone section; that of the posterior, one-quarter. Each flap should be rectangular, and should include all the tissues down to the bone. After section of the bones the anterior flap should be folded over the bones and stitched to the posterior flap (Fig. 392). The advantages of the method are that it affords good drainage and furnishes a serviceable stump. The principal disadvantage is that it requires a high division of the bone, and therefore involves a greater sacrifice of the limb than other methods.

Fig. 392.



Amputation by Teale's method.

The Racket-shaped Method.

This method is a modification of the circular method, and consists in an oval or circular skin incision extending around the limb which is joined by a perpendicular incision extending for a variable distance upward, along the bone. It is applicable to the fingers and toes, especially when the amputation is performed at the base of the digit.

A similar incision is also extensively employed at the hip- and shoulder-joints, but in these regions the flaps are made of skin and muscle.

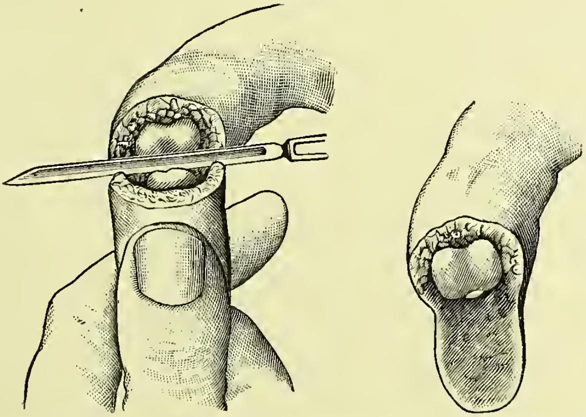
SPECIAL AMPUTATIONS.

Amputation of the Fingers.

It should be remembered that on the dorsal aspect of the fingers the joint lies below the knuckle, which is formed by the inferior extremity of the bone alone. The distal joint lies one-twelfth of an inch below its bony prominence, the interphalangeal joint one-sixth of an inch, and the metacarpophalangeal joint one-third of an inch below the knuckle (Jacobson). The creases on the palmar aspect practically correspond to the joint-line for the two distal joints; the upper one lies about three-fourths of an inch below the metacarpophalangeal joint.

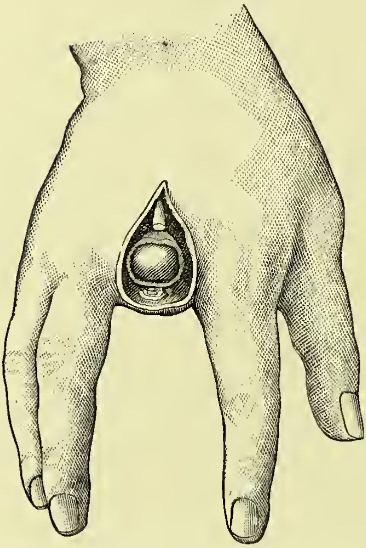
In amputations through the phalangeal joints the method by the long palmar flap is to be preferred for the reason that the flap is thicker, better nourished, possesses greater tactile sensibility, and the scar is above and out of the way. The extremity of the finger should be firmly grasped and partly flexed. A long, thin-bladed knife should then incise the skin immediately over the joint-line, enter the joint, and then pass beneath the head of the distal phalanx, and by one or two sawing movements cut a long rounded palmar flap. This is turned up and united to the edge of the dorsal incision by three or four sutures of silk or silkworm gut. Occasionally one or two small vessels may need ligation (Fig. 393). In amputations at the interphalangeal joint Tiffany recommends including the tendon and its sheath in the sutures, to insure good voluntary movement of the stump.

Fig. 393.



Amputation of a finger by the long palmar flap. (After Esmarch.)

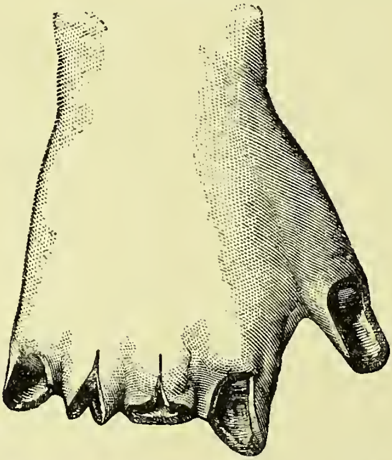
Fig. 394.



Racket-shaped incision for amputation of the finger at the metacarpophalangeal joint. (After Rotter.)

In amputations between the joints the double skin flap may be employed, either antero-posterior or lateral. If the former is employed, the palmar should be the longer, for reasons already given. In metacarpophalangeal amputations the lateral flap or

Fig. 395.



Illustrating various finger amputations. (Farabeuf.)

the racket-shaped incision should be employed. Amputations at the distal joint of the thumb should be by the palmar flap; at the metacarpophalangeal or carpometacarpal joints, by the racket incision (Figs. 394 and 395).

In traumata of the hand it must be remembered that fingers or parts of fingers may often be saved even after severe lacerations and compound fractures, and that an effort should always be made to retain as much of the thumb as possible. It should also be remembered that an immovable stump of a finger is worse than useless. In many cases atypical amputations are possible, and irregular but viable strips of tissue can often be employed to cover bone and fill up gaps in the soft parts.

Amputation at the Wrist.

Amputation at the wrist may be accomplished by the double-flap method, by the long palmar flap, or by the external flap; in the latter case the flap is taken from the external surface of the thumb as high as the metacarpophalangeal joint (Dubreuil). Of these, the palmar flap method is to be preferred. In this an incision is made from one styloid process downward on the palm of the hand to a point opposite the middle of the metacarpal bone, then transversely to the opposite side and upward to the other styloid, making a rectangular flap with rounded edges. The flap consists of skin, subcutaneous fat, and a small portion of the muscle from the thenar and hypothenar eminences. The two extremities of this incision are joined by a transverse dorsal incision. The joint is then opened from the dorsal side and the disarticulation completed by division of the ligaments and tendons. The styloids are next shortened, care being taken to avoid severing the attachment of the supinator longus, the palmar flap turned upward and united to the edge of the dorsal incision.

Amputation of the Forearm.

Amputation of the forearm is usually accomplished by the double-flap method. In the lower portion the flaps should be of skin from the flexor and extensor surfaces. In the upper portion the muscles may be included in the flaps. The flaps may be equal in length, but the long dorsal and short palmar method is to be recommended. When possible, the bones should be divided below the attachment of the pronator radii teres muscle, to insure pronation and supination of the stump, an important factor in contributing to the usefulness of an artificial arm and hand.

Amputation at the Elbow-joint.

The circular, the double-flap, or the long anterior or posterior flap methods, may all be employed in this region. Of these, the long anterior flap, consisting of skin and muscle, is to be preferred. This is made either by transfixion or by cutting from without inward, and is joined posteriorly by a short flap of skin. When the region of the joint is exposed, it is opened from the outer side and disarticulation effected by division of the ligaments and tendon of the triceps muscle. The fleshy anterior flap falls over the condyles and is attached to the posterior flap by a number of cutaneous sutures. It is especially important in this amputation that the flaps be sufficiently long to avoid tension, otherwise retraction may occur and one or both condyles may protrude.

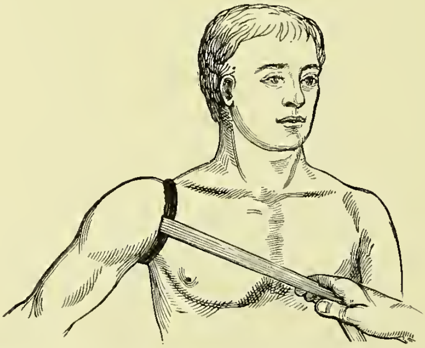
Amputation of the Arm.

The conditions here are favorable to almost any method of amputation. The circular and the double-flap methods are the ones usually employed, and have been described in the earlier part of the chapter.

Amputation at the Shoulder-joint.

Hæmostasis in this operation is secured best by a preliminary ligation of the axillary artery in its upper third. The use of the rubber tourniquet passed beneath the arm and drawn upward and clamped above the clavicle, and held in place by an assistant (Fig. 396) or by means of the Wyeth pins, introduced one

Fig. 396.



Esmarch's strap applied in high amputation of arm. (Smith.)

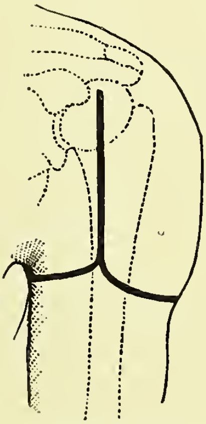
through the anterior and one through the posterior fold of the axilla, each emerging one inch within the tip of the acromion, is a satisfactory method in thin subjects.

Two methods are to be recommended for this amputation, the deltoid flap method and the racket incision.

The **deltoid flap method** consists in a long oval skin and muscle flap, including the greater part of the deltoid. This is made by transfixion or by a cut from without inward extending from the coracoid process downward to the point of insertion of the deltoid, then backward to the root of the acromion. The tissues are raised from the bone and retracted well upward. When the head is exposed, the capsule is incised, the muscular attachment severed, and the head forced out of the socket. The blade of the knife is then passed behind the head, and a short posterior flap made by cutting directly downward. The large deltoid flap is trimmed to fit the opening thus made, and after the vessels are secured is stitched to the lower margin of the wound, a large wick of gauze being left in the glenoid cavity for drainage.

The **racket-shaped incision** is the one generally employed. In it the perpendicular portion of the incision may be made from a point near the coracoid process (Spence) (Fig. 397), from a point between this and the acromion (Farabeuf), or from a point just beneath the acromion on the outer aspect of the arm (Larrey). In all of these the perpendicular incision is carried downward to a point opposite the attachment of the pectoralis major muscle to the humerus. From this point the incision is carried around the arm as in a circular amputation. The vertical arm of the incision is next carried to the bone and the head exposed by lateral retraction of the two flaps thus formed. The capsule is divided, the muscular attachments cut, the head disarticulated, separated from the remaining soft parts, and the arm removed. After ligation of the vessels the wound is closed with generous gauze drainage.

Fig. 397.

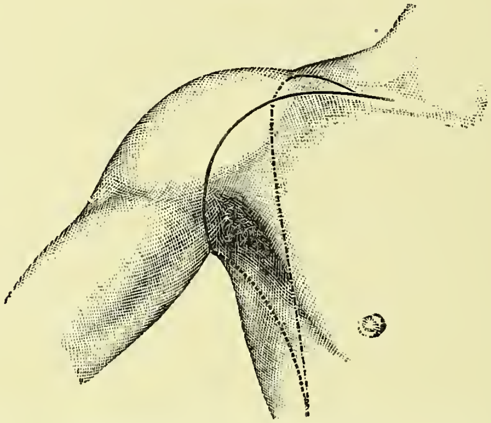


Disarticulation at the shoulder, Spence's method. (Stimson)

Interscapulothoracic Amputation.

In interscapulothoracic amputation, or removal of the entire shoulder-girdle, an incision is made from the sternoclavicular junction along the clavicle to the coracoid process; from this point the incision passes downward to the junction of the arm with the anterior fold of the axilla, then around, beneath the arm, to the edge of the latissimus dorsi muscle ; crossing this it passes downward to the angle of the scapula, then upward across the spine of the scapula to join the incision over the clavicle about its middle (Fig. 398). This incision simply includes the skin and subcutaneous areolar tissue. The incision over the clavicle is next deepened, the clavicle disarticulated from the sternum and carefully raised throughout its entire length. The attachment of the pectoralis minor to the coracoid process is severed and the brachial plexus and axillary vessels exposed. The vessels are double ligated and divided, and the nerve-trunks cut.

Fig. 398.



Amputation of the arm, scapula, and part or all of the clavicle. (The dotted line represents the part of the incision which lies on the posterior aspect of the body.) (Treves.)

The remaining portions of the incision are then deepened, the scapula fully exposed, its muscular attachments divided, and the entire upper extremity removed.

The posterior scapular and suprascapular arteries should be clamped and ligated; also a number of other smaller vessels. The two flaps, pectoro-axillary and the cervicoscapular, are then approximated and secured by silk-worm gut or button sutures. The operation is one of the severest known to surgery, and requires often the maximum of speed and stimulation. It should never be undertaken unless the surgeon is equipped with the best assistance and every facility for controlling severe shock and administering the most vigorous stimulation.

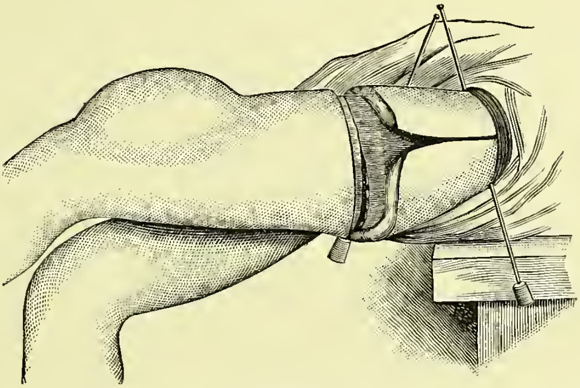
Amputation at the Hip-joint.

What has just been said in regard to the removal of the entire upper extremity applies with equal force to amputations at the hip-joint. Formerly the operation was attended by a very high rate of mortality. Of late, however, owing to better means of controlling hemorrhage and better methods of effecting removal of the limb, the death-rate has been materially lessened.

Many methods of controlling hemorrhage have been employed in this operation; two only are to be recommended, that by the rubber tourniquet and Wyeth's pins, and that by compression of the common iliac through an abdominal wound, as suggested by McBurney.

In the Wyeth method two long steel pins or skewers are thrust through the soft tissues, the first pin entering just below and a little to the inner side of the anterior superior spinous process and emerging on a level with the point of entrance, but four or five inches to the outer side of the limb. The second pin is introduced through the adductor muscles, near the ramus of the pubes and to the inner side of the femoral vessels, and is made to emerge one inch in front of the tuberosity of the ischium. After protecting the points of these pins by corks, a firm piece of rubber tubing is wound several times around the limb above the pins and secured by a clamp (Fig. 399). If an Esmarch bandage is employed previous to the application of the tourniquet, the operation will be practically bloodless, as this method controls every vessel supplying blood to the field of operation.

FIG. 399.



The needles and constrictor applied: circular and longitudinal incisions for skin flap. (Wyeth.)

The McBurney plan consists in preliminary laparotomy by the intermuscular method, and compression of the common iliac artery by the hand of an assistant introduced into the peritoneal cavity. The author has employed this plan, but without opening the peritoneal cavity, by stripping the peritoneum from the iliac muscle after separation of the muscular fibres. The artery is as easily and quickly exposed, and, after the operation is completed, the tissues fall readily into place, and require only a few sutures and closure of the cutaneous wound.

While both of these methods may be relied upon to control hemorrhage absolutely, the author would prefer the Wyeth method in a case of shock where speed was an important factor, and the McBurney method in the case of a very fleshy individual.[1]

As the racket-shaped amputation has practically superseded all of the older methods, it alone will be described. For a description of the other methods, the reader is referred to works on operative surgery.

The *operation* is performed in the following manner: The patient is placed on the operating-table with the hips projecting slightly over the edge. The sound leg is held out of the way by one assistant, and the diseased limb supported in the extended position by another. A circular incision is then made six inches below the tip of the great trochanter, and a cuff of skin and subcutaneous tissue retracted. A vertical incision is then made down to the bone from the outer side of the cutaneous incision, to a point one inch above the great trochanter. The two triangular flaps thus created are sharply retracted and the bone shelled out of its muscular bed by sharp and blunt dissection. The capsule of the joint is next opened and disarticulation effected by strong adduction and a rotary motion of the limb. As soon as the bone leaves the socket the posterior muscular attachments are severed and the limb removed. The femoral artery and vein should be ligated separately. Ligation will also be required for the profunda and descending branch of the external circumflex. After the tourniquet is removed and all other bleeding points secured, a cigarette drain should be introduced to the acetabulum, and the flaps approximated and held by a sufficient number of silk-worm gut sutures.

Some operators prefer to place the patient on the sound side, and begin by making the vertical incision, entering the knife one inch above the trochanter, carrying the incision downward parallel with the bone for five inches, then encircling the limb. After dissecting up the skin from the muscles for a distance of two or three inches, the muscles are divided to the bone by a circular sweep of the knife and the head disarticulated as in the other method. Rose and Carless advise making the perpendicular arm of the incision immediately over the femoral vessels.

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[1] On one occasion the writer experienced considerable difficulty in disarticulating the hip of a patient weighing 300 pounds, when the Wyeth pins were used, due chiefly to the impossibility of extending the vertical incision sufficiently high above the trochanter.

It is important after this operation to support the parts by a firmly applied dressing, as the cut muscular surfaces are apt to ooze considerably; and if the dressings are loosely applied they soon become saturated and have to be removed. If the wound is aseptic, it is desirable to allow the primary dressing to remain in place for ten days or two weeks.

Amputation of the Thigh.

Amputation of the thigh, like amputation of the arm, may be performed by almost any one of the methods described in the beginning of the chapter. The quickest operation is the double-flap method by transfixion, and is therefore indicated in old and debilitated subjects, and in patients suffering from severe shock or sepsis.

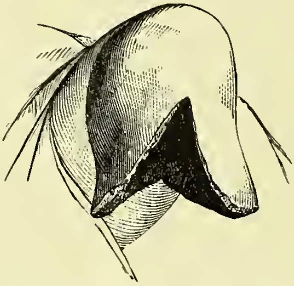
The osteoplastic operation gives the best results, if viewed from the standpoint of subsequent weight-bearing function, although the Teale method also gives, as a rule, an insensitive stump. Conical stump is quite common in amputations of the thigh, especially in the lower third. This is due largely to the fact that the flexor muscles retract much more than the extensors, leaving the bone more or less exposed and covered only by the skin. To remedy this, Dawbarn begins the operation by "ham-stringing" his patient, or dividing the tendinous attachments of the external and internal flexors just above the knee by a stroke of the knife. This allows retraction to take place before the flaps are cut. On account of this tendency to muscular retraction it is desirable in thigh amputations to suture the muscles over the divided extremity of the bone. For this purpose, buried sutures of catgut should be employed.

Amputations at or near the Knee-joint.

A number of excellent operations have been devised for amputation at or near the knee-joint.

The **bilateral flap operation** of Stephen Smith is one of the most popular, and has the advantage that the scar is situated posteriorly and well out of the way of the bearing point. A curved incision is made, beginning one inch below the tubercle of the tibia and extending downward and outward over the fleshy part of the leg to a point behind on the calf opposite the tubercle; then upward in a vertical direction to the middle of the popliteal space. A similar incision is made on the inner side of the leg, but extending about one inch lower on the calf, and joining the first in front and behind. These incisions are next carried down to the bone, forming two musculocutaneous lateral flaps, which are well retracted and the line of articulation exposed. The patellar tendon is then divided, the joint opened, the leg flexed, the lateral and crucial ligaments divided, the knife carried behind the head of the tibia, and the leg severed by a downward stroke. After securing the vessels the flaps are joined by sutures of silk-worm gut, a drainage-tube introduced at the upper and posterior angle of the wound, and the dressings applied (Fig. 400).

Fig. 400.



Amputation by lateral flaps. (Roberts.)

Carden's method consists in a supracondyloid amputation with a long anterior and a short posterior flap. A curved anterior incision is made from one condyle to the other, extending downward to the tubercle of the tibia. This is dissected upward to a point above the patella. A posterior incision is then made connecting the two extremities of the anterior cut, and is carried through all the soft parts to the bone. The muscular structures on the anterior aspect of the thigh are then freely incised and the bone sawn just above the condyles.

The Gritti or Stokes Method.—This is an osteoplastic amputation. A curved anterior incision is made, as in the Carden operation, extending from one condyle to the other through the patellar ligament. The flap is retracted strongly upward, the leg acutely flexed, and the joint freely opened. The blade of the knife is then passed behind the head of the tibia and a short posterior flap cut from within outward. The articular surfaces of the femur and patella are then sawn off, exposing cancellous bone-tissue. In the Gritti operation the femur is sawn through the condyles; in the Stokes operation, just behind. The latter is to be preferred, as its cut surface more accurately fits the patella.

The anterior flap with the adherent patella is then allowed to fall over the cut surface of the femur and is sutured to the edge of the posterior incision. If any tendency to displacement of the opposed bony surfaces is present, they are held by one or more chromicized catgut sutures passed through holes drilled in the two bones. It is desirable in this operation to remove as much of the synovial membrane as possible, and to touch the remaining portions with pure carbolic acid, to promote adhesion and to prevent accumulation of synovia. Rubber tissue drains should be left in each angle of the wound.

Amputation of the Leg.

In the upper half of the leg the circular or the transfixion method may be employed. In the lower portion Teale's method or the long posterior flap operation is to be preferred, if the condition of the soft parts will admit. Bryant advises in the lower third a circular amputation with a periosteal flap cut from the subcutaneous surface of the tibia and retaining its connection with the skin. After division of the bones the periosteal flap is placed over the cut surface of the tibia and the cutaneous edges united obliquely, so that the scar lies between the bones.

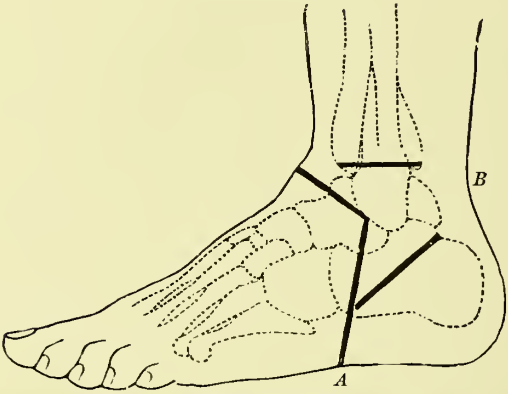
In all amputations of the leg the fibula should be sawn about one-half inch above the tibia. Bull advises an oblique section of the crest of the tibia before closure of the wound.

Amputation at or near the Ankle-joint.

The Syme Amputation.—Enter the knife at the tip of the external malleolus and carry the incision, extending to the bone, across the sole to a point half an inch below the tip of the internal malleolus. Dissect this heel flap backward from the os calcis until the tendo Achillis is reached. Then connect the two extremities of the plantar incision by an oval anterior incision, dividing all the soft parts to the bone. The joint is next opened from in front, the lateral ligaments divided, and the foot removed. The flaps should then be retracted upward, and the malleoli, or even the entire articular surface of the bones, removed. After traction on and division of the exposed tendons, and ligature of the vessels, the flaps are approximated and united. Drainage may be secured from the angles of the wound or by means of a separate opening at the bottom of the cup-shaped dead space in the heel flap.

The Pirogoff Operation.—The incisions for this operation are practically the same as in Syme's, the plantar cut being made about half an inch further forward. The heel flap is dissected from the os calcis only about one inch from the incision. The joint is then opened, the lower ends of the tibia and fibula removed, and the calcaneum sawn obliquely through in the line of the plantar incision, removing its articular surface and leaving the posterior portion attached to the heel flap. When the heel flap is raised up, the cut surface of the calcaneum is brought in contact with the cut surface of the tibia and held in that position by the cutaneous sutures. This gives an excellent stump with but little shortening of the limb (Fig. 401).

Fig. 401.



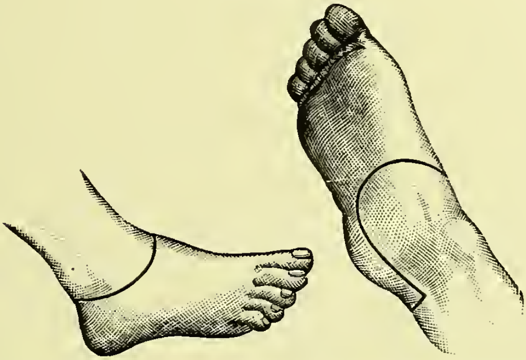
Pirogoff's amputation: *A*, cutaneous incision (outer side); *B*, line of section of the bones. (Stimson.)

The Roux Operation.—Enter the knife one-half inch above the insertion of the tendo Achillis, carry the incision by a downward curve beneath the external malleolus to a point in the middle of the instep one inch in front of the articular edge of the tibia, then downward and inward to the middle of the sole, and backward and upward to the point of beginning (Fig. 402). Carry the incision to the bone throughout and raise the plantar flap. Open the joint from the outside, remove the foot, saw off the malleoli, and unite the flap with silk-worm gut.

Mid-tarsal amputations are not to be recommended.

The Lisfranc Amputation.—*Disarticulation at the tarsometatarsal joint.*—Extend the foot and make an anterior curved incision from a point just in front of the base of the first to the base of the fifth metatarsal bone. Divide all the tissues down to the bone and separate the metatarsal bones from the cuboid and the cuneiform bones, remembering that the middle cuneiform bone is shorter than its fellows, and that the second metatarsal bone projects upward into this mortice. When the joint is freely opened, pass the blade of the knife behind the metatarsal bones and cut a thick U-shaped flap from the plantar surface of the foot to the base of the toes. Next remove all fragments of tendons, ligate the bleeding vessels, and turn the plantar flap upward and attach it to the dorsal by a sufficient number of silk-worm gut sutures.

FIG. 402.



Amputation through the ankle-joint by large internal lateral flap. (Roux.)

Hey's operation differs from this in that he removes the lower projecting extremity of the inner cuneiform bone.

In **Skey's operation** the base of the second metatarsal bone is sawn off even with the internal cuneiform.

Amputation at the Metatarsophalangeal Joints.

Amputation at the metatarsophalangeal joints, or disarticulation of all the toes, is an operation rarely called for except for gangrene from frostbite or Raynaud's disease. Both dorsal and plantar flaps should be cut to the web of the toes, and an attempt made to bring the scar as near the dorsal aspect of the stump as possible.

Amputations of the Toes.

Amputations of the toes are carried out by the same methods as in amputation of the fingers. In the metatarsophalangeal disarticulations the bilateral flap or racket method is usually employed. In disarticulation of the terminal phalanges the long plantar flap method is to be preferred.

Treatment of the Stump after Amputations.

The stump after complete healing of the wound of amputation should be treated by massage, hot and cold baths, bandaging, and if necessary by some apparatus to prevent permanent flexion of the remaining parts.

As soon as the wound is firmly healed and all sensitiveness has disappeared from the end of the bone, an artificial limb should be fitted and the patient urged to make early efforts to use the extremity. Delay in making this effort is often a serious mistake, for the reason that patients become accustomed to crutches, and are therefore unwilling to endure the discomfort and pain which always accompany the early efforts to use an artificial leg.

The Use of Artificial Limbs.

With a view to determining the conditions which favor the successful use of an artificial limb after amputation of the lower extremity, Dr. F. T. Murphy addressed a circular letter to 500 patients treated at the Massachusetts General Hospital from 1888 to 1892. He also made inquiries of eleven well-known firms manufacturing artificial limbs. From the replies he received, he concludes that a serviceable weight-bearing stump is best secured by covering the end of the bone by a layer of muscle rather than by a simple skin flap; that a periosteal covering of the end of a bone is desirable; that in leg amputations the fibula should be cut at a higher level than the tibia; that the sharp subcutaneous tibial edge should be removed, and that every effort should be made to avoid wound infection. He also found that, as a rule, all partial amputations of the foot and most amputations at the ankle were unsatisfactory, but that a tibial stump between 6 and 8 inches in length is to be preferred, as it gave to the patient an increased sense of security, far more comfort, and a greater degree of strength in the subsequent use of his artificial limb. Amputations at the knee-joint are inferior to those just above the condyles.

In general it was found, as a result of these investigations, that if we aim to secure the greatest comfort in the use of an artificial extremity, we should avoid joint amputations, provide adequate muscular covering for the end of the bone, and make every effort to secure primary union.

CHAPTER XXXI.

DEFORMITIES AND THEIR CORRECTION.

Scoliosis, or Rotary Lateral Curvature of the Spine.

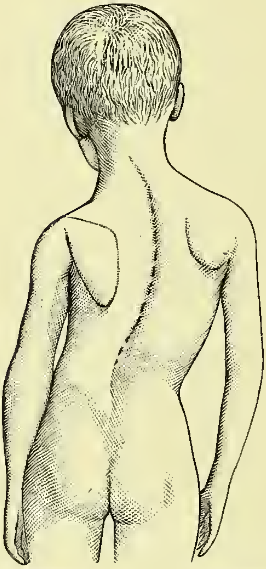
Scoliosis is an acquired deformity of the trunk, characterized by a more or less well-marked lateral bending and twisting of the spinal column, and consequent asymmetry in the appearance of the thorax, abdomen, and extremities. The disease develops in early life, in the majority of instances before the tenth year, and is somewhat more common in girls than in boys.

A slight compensatory curve in the spine will result from a faulty position of the head, shoulder, or body, habitually assumed in standing, walking, or sitting; also from an inequality in the length of the legs, or from an asymmetric development of the pelvis or muscles. Defects in sight or hearing, torticollis, improper postures assumed in school, ill-fitting shoes, and overuse of an extremity for any cause are, therefore, to be regarded as causes of scoliosis. As the child grows, these slight compensatory curves in the spine become exaggerated, and are corrected with more and more difficulty. At length changes occur in the bones, as atrophy of the vertebral bodies on the concave side and thickening on the convex aspect, distortion of the sagittal plane, and general asymmetry of the individual vertebræ, resulting in permanent deformity.

As the spine is bent, rotation on its vertical axis occurs. In this rotation the bodies of the vertebræ are directed toward the convexity of the lateral curve, which causes a bulging of the costal arches posterially on that side, with a compensatory retraction of the thorax on the opposite side. This distortion of the thorax causes pressure on its contained viscera, occasionally resulting in pathologic changes. Atrophy and lengthening of the ligaments and muscles are observed on the convex side of the curve, with shortening of these structures on the concave side.

The **symptoms** of scoliosis are, in the earlier stages, simply the occurrence of "round shoulders" in a child, a lowering of one shoulder, or a slight departure from the normal erect position of the body in standing or walking. There is also a change or asymmetry in the triangles formed by the dependent arms and the lateral aspects of the trunk. This may easily be corrected by voluntary effort on the part of the patient, but the corrected posture is tiresome and the child soon assumes the faulty one. As the disease progresses, the postural deformity becomes more marked, and an abnormal prominence of the ribs may be noticed on one side, especially when the child bends forward and the thorax is examined from behind. Excessive prominence of one hip, the fact that the nipples are not in the same horizontal plane, or that one scapula is more prominent than the other, should also be regarded as signs of scoliosis. On examining the patient from behind and applying friction to the spine, the extent of curve can be appreciated by observing the red line of the spinous processes. Fig. 403 shows an example of a well-marked type of the disease.

FIG. 403.



Severe lateral curvature (back view). (Lovett.)

Treatment.—In the early stages of the disease the treatment should consist in removing the cause of the faulty attitude, and in the use of light gymnastic exercises to develop the weakened muscles which are employed to hold the body in a correct posture. For this purpose the ordinary setting-up drill of military tactics is the one to be recommended. If the disease is more advanced, heavy gymnastics to overdevelop the muscles, are often of advantage. Supporting corsets of plaster-of-Paris, paper, or leather, are often employed to hold the body in a normal position if the muscles are easily tired and the child constantly assumes faulty attitudes which tend to exaggerate the deformity.

In the severer cases in which there is fixed bony deformity, forcible correction by means of traction straps, and the application of a plaster jacket while the patient is held in the corrected position, constitute the best treatment. A few days or weeks later another jacket is applied in the same manner, and when the deformity is finally overcome a removable leather or celluloid jacket should be worn, and heavy gymnastics practised daily. Metal braces are occasionally useful for this condition. For a description of these the reader is referred to a work on orthopedic surgery.

The prognosis in advanced cases is not favorable.

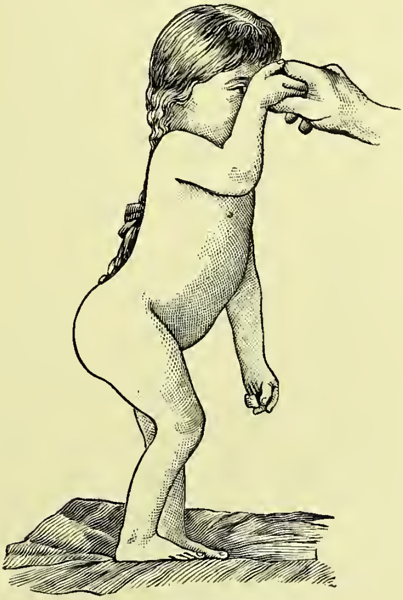
Spondylolisthesis.

Spondylolisthesis is an extremely rare deformity, due to a subluxation forward of one of the lower lumbar vertebræ or a projection forward of the upper sacral segment. This may occur as a result of some congenital defect or an abnormal position of the spine during intra-uterine life of the fœtus; or it may develop during childhood or adult life from trauma or joint-disease. As a result of this displacement there is an abnormal increase in the lumbar curve of the spine (excessive lordosis), a diminution in the normal obliquity of the pelvis, causing tension on the anterior ligaments of the hip and a consequent flexed position of the thighs (Bradford and Lovett).

The **symptoms** of the disease are a faulty position when standing and a peculiar waddling, duck-like gait.

When standing erect, the body is bent forward, there is a marked prominence of both hips, and the thorax seems abnormally near the pubic crest. Complete extension of the thighs is impossible (Fig. 404). Vaginal or rectal examination reveals the presence of a prominent sacral or sacrolumbar bony projection.

Fig. 404.



Spondylolisthesis.

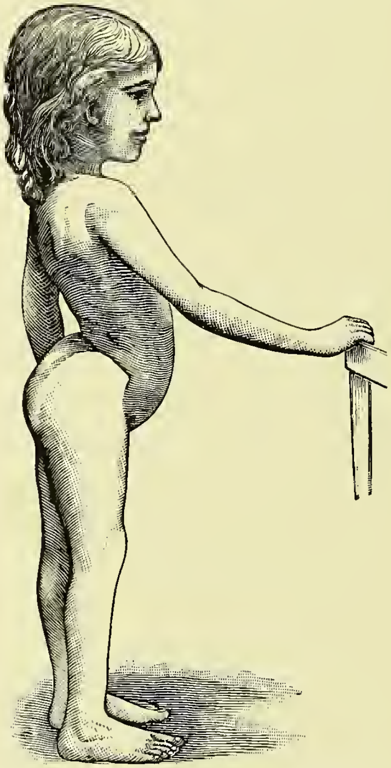
The disease resembles closely double congenital dislocation of the hip, but can be distinguished from that malady by the absence of vertical mobility of the femur, and the fact that the trochanters are not above Nélaton's line. There is no treatment.

Congenital Dislocation of the Hip.

Congenital dislocation of the hip is a comparatively rare malformation. It is more common in girls than in boys. In more than one-third of the cases the disease is double.

In this condition the head of the femur occupies a position above and behind or in front of the acetabulum. The capsule of the joint is still adherent to the rim of the acetabulum, but is markedly thickened and elongated, so that the lower portion adherent to the acetabular rim is contracted and the upper and inner portion is firmly attached to the new socket. The head of the bone in these cases is often underdeveloped, and the acetabulum shallow and filled with fibrous tissue and fat.

Fig. 405.



Lordosis and prominence of trochanter in congenital dislocation of hip. (J. S. Stone.)

The **diagnosis** of congenital dislocation is often difficult in young and fat children. As a rule, these children walk late, and the gait is a peculiar waddling one, accompanied by an exaggerated swaying of the body. The hips are exceedingly prominent and the perineal space widened. The trochanters are above Nélaton's line, and the head of the bone may occasionally be felt on the dorsum of the ilium. There is marked compensatory lordosis, and the femur can be moved upward and downward for an inch or more (Fig. 405).

Treatment.—Two methods of treatment are in use for the correction of this deformity: reduction by manipulation or the bloodless operation of Lorenz, and the method by open operation recommended by Hoffa. The former is to be recommended in children between the ages of two and ten, although it is occasionally successful between ten and thirteen years of age; the latter operation after the age of ten and in cases in which the method by manipulation has failed or where relapses have occurred.

Lorenz's method consists in overstretching and rupturing the contracted and shortened muscles by traction, extreme abduction, flexion, and extension, and subsequently effecting reduction by manipulation as in acquired dislocations. The limb is then placed in a position of extreme abduction and held by a firm plaster spica, which should be left in place for from six to eight months. After its removal the leg should be gradually brought into normal position.

Hoffa's method consists in making an incision from the anterior superior spinous process downward and backward, passing behind the great trochanter. This incision is deepened until the capsule of the joint is exposed. The soft parts are then thoroughly retracted, the capsule opened, the acetabulum examined and its contents removed, the head of the bone dislocated from its false position and placed in the socket. The capsule is then sutured, the wound closed with drainage, and the thigh fixed in a position of flexion and abduction by a plaster cast.

Osteotomy may be necessary later to bring the limb into proper position.

Congenital dislocations of the knee, patella, ankle, shoulder, elbow, and wrist are extremely rare. For a description of them the reader is referred to works on Orthopedic Surgery.

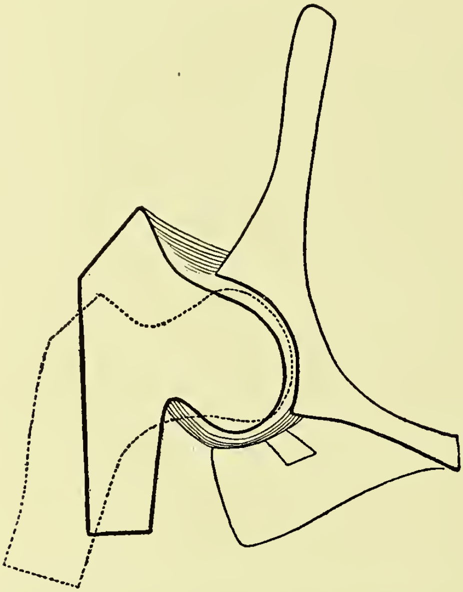
Coxa Vara.

Under normal conditions in childhood the angle of junction of the axis of the neck of the femur with that of the shaft is an obtuse one. As a result of complete or incomplete fracture of the neck of the femur in childhood, or as a result of other abnormal conditions, the exact nature of which is not well understood, a bending of the neck occurs so that its junction with the shaft approaches a right or even an acute angle. This results in an elevation of the trochanter which may be well above Nélaton's line, an adduction and eversion of the limb, and an inability to abduct the thigh beyond a certain point (Fig. 406).

In double coxa vara the abduction may be so marked that the legs are habitually crossed, and locomotion becomes greatly embarrassed or even impossible.

The **symptoms** of this condition are at first irritation about the hip-joint, with unusual fatigue on walking, slight limping, a peculiar swaying gait, and, in double coxa vara, a well-marked lordosis on standing. The limb is shortened, the foot everted, and the trochanter is felt higher than normal. Extreme abduction is limited by contact of the tip of the trochanter against the rim of the acetabulum. The condition is occasionally associated with rickets, and scoliosis frequently results when the disease is unilateral.

Fig. 406.



Cross-section of the pelvis and the deformed femur. A scheme to show the effect of the deformity in limiting abduction of the limb. The dotted outline shows the normal relation. (Whitman.)

The **treatment**, as advised by Whitman, should consist in subtrochanteric osteotomy, correction of the deformity by extreme abduction, and fixation of the limb in this position by a plaster cast until the bone is firmly united.

In cases of traumatic coxa vara, where the patient is seen before solid union has taken place, or in cases due to rickets, where the bone is still soft and yielding, the deformity can sometimes be reduced by manipulation (extreme abduction), after which it should be held in the corrected position by plaster, as after operation.

Coxa Valga.

A rare condition, the reverse of coxa vara, in which the angle made by the shaft and neck is more obtuse than normal. The diagnosis is rarely made except by the *x*-rays. A few cases have been reported as being relieved by an osteotomy of the neck and correction of the deformity by elevating the limb.

Knock-knee.

Knock-knee is an internal angular curvature of the lower extremity, the apex of the angle being at the knee-joint. This occurs chiefly in infancy and early youth. In the infantile variety it is generally due to rickets, and the deformity may occur before attempts at walking have been made. Generally, however, the deformity appears with the first attempts at walking, and shows a strong tendency to progress as the use of the limbs is increased. In the adolescent type the disease appears between the ages of ten and eighteen, and is commonly associated with occupations requiring constant standing.

The chief pathologic factors of the deformity are increased length of the internal condyle of the femur and atrophy of the external with or without changes in the head of the tibia. With this there may be a curve in the shaft of the femur and relaxation of the internal lateral ligament of the joint.

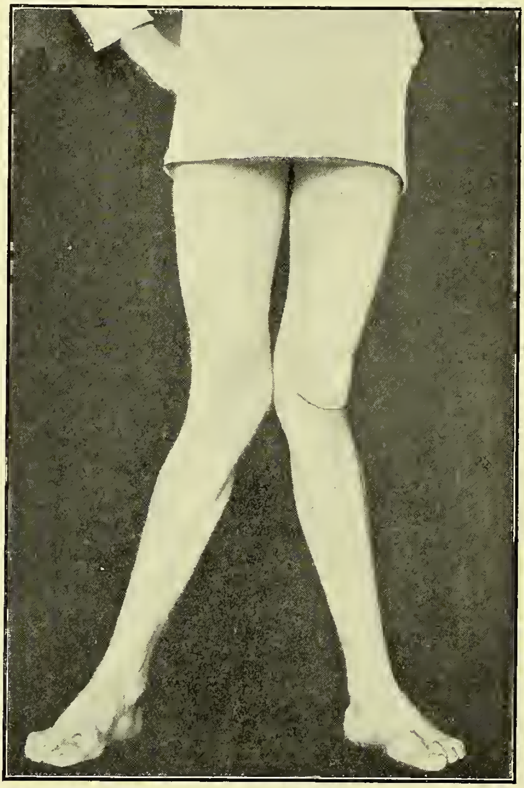
The **diagnosis** is easily made by inspection (Fig. 407). In double knock-knee the gait is peculiar, owing to the necessity of separating the thighs to allow the advancing knee to pass its fellow in walking.

If the legs are flexed on the thighs, the deformity partly disappears; if the thighs are also flexed, the deformity may be completely absent. In the extended position the examination should always be made with the condyles flat on the examining-table.

With well-marked knock-knee there are often an external rotation of the tibia and flat foot.

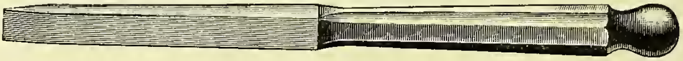
Treatment.—In the earliest stage of the deformity, up to four years of age, much may be done to prevent its increase by massage, general tonic measures, and some corrective apparatus applied to the legs. In the severer forms, and after four years of age, operative treatment only is to be recommended; and of the various methods, supracondyloid osteotomy gives the best results. It is performed as follows:

FIG. 407.



Knock-knee. (Whitman.)

FIG. 408.



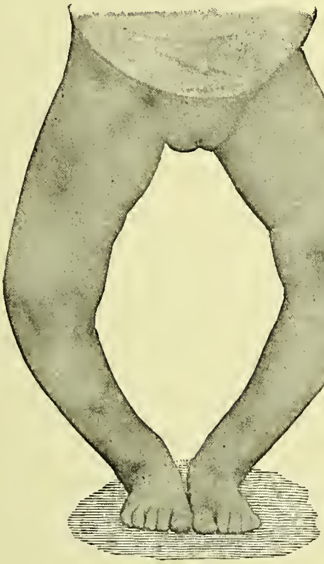
Osteotome.

The knee should be flexed and the limb placed on a sand-bag with the inner surface uppermost. A small vertical incision is made one inch above the adductor tubercle and an osteotome (Fig. 408) introduced, turned, and its cutting edge applied transversely to the long axis of the bone. With a mallet the osteotome is driven three-quarters through the bone, care being taken to cut through cortex both above and below. The leg is next extended, the limb grasped above and below the joint, and the femur fractured. The deformity is thus corrected and the limb placed in a plaster cast, after suture of the wound, and the application of a pad of sterile gauze.

Bow-legs.

This deformity, which consists in an outward curvature of the limb, is, like knock-knee, commonest in children. It rarely occurs before early attempts at walking have been made or after the fourth year, and is almost always due to rickets. It is more common than knock-knee, the proportion being about 8 to 5.

Fig. 409.



Bow-legs. (Lovett.)

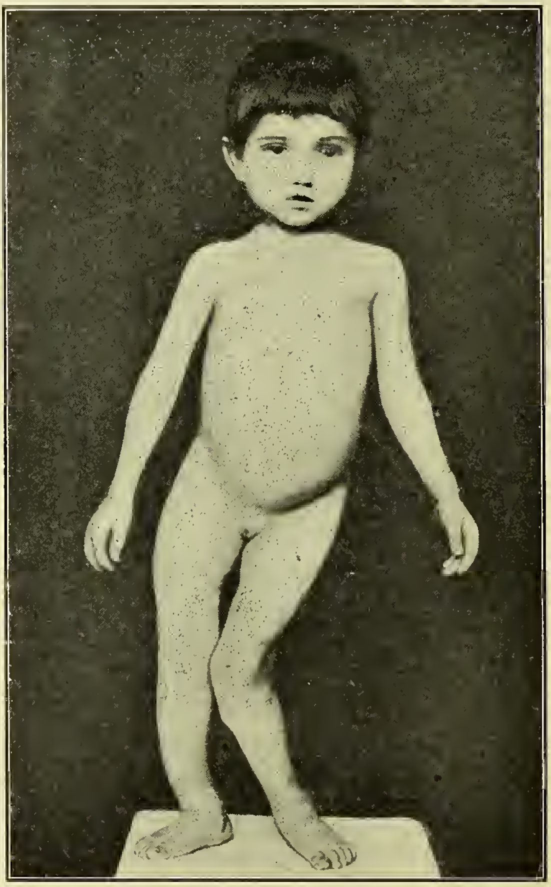
In this condition the deformity is caused by a bending of the femur or tibia, or of both combined, from inability of the softened bones to support the weight of the body.

In the majority of cases there is a gradual outward bowing of both the femur and tibia. In other cases the bending is limited to the lower third of the tibia. In some instances there is, in addition to the outward curve, an antero-posterior curve of one or both bones, the convexity being forward. Flat foot is generally present (Fig. 409).

It occasionally happens that bow-leg and knock-knee are seen in the same individual (Fig. 410).

The **diagnosis** is easily made. The child stands with the feet apart; the knees are widely separated and the feet everted. On walking, the body sways from side to side, and the child instinctively attempts to invert the feet to help maintain his equilibrium. To determine whether the femur is involved, the legs are crossed until the knees are in contact; if an oval separation of the thighs still exists, there is curvature of the femur. Spontaneous cure of the deformity without treatment undoubtedly occurs in certain cases, the number of such cases being greater than in knock-knee.

FIG. 410.



Knock-knee and bow-leg. (Whitman.)

Treatment.—As soon as a tendency to bow-legs is noticed, walking should be discouraged and a vigorous tonic and antirhachitic treatment inaugurated. Steel braces and other forms of supporting apparatus may be useful up to four years of age, to prevent increase in the deformity. Gradual correction by bending the limbs and maintaining the position by plaster casts will bring about a cure in cases in which the bones are still soft. After the bones have become hardened, however, operative treatment is indicated. Osteotomy of the tibia or femur, or of both combined, at the point or points of greatest curvature, with immediate correction of the deformity and the application of a plaster cast to the entire limb, including the pelvis, is the method of choice.

Club-foot.

The term club-foot is generally employed to indicate any deformity, either congenital or acquired, which interferes with the normal plantigrade attitude of the foot in walking. Used in this sense, the term is synonymous with the word *talipes*, which literally signifies a walking upon the ankle or tarsus, a condition often present in the severer grades of club-foot. Four regular varieties of club-foot are described: *talipes varus*, in which the foot is turned inward; *talipes valgus*, in which the foot is turned outward; *talipes equinus*, in which the foot is in a position of extreme plantar flexion; and *talipes calcaneus*, in which the foot is in a position of extreme dorsal flexion. Clinically, these forms are often associated, as in *talipes equinovarus*, and *talipes calcaneovalgus.*

The causes of congenital club-foot are not well understood, but most authorities agree that the deformity is probably due to some restriction to the free motions of the foot and ankle during intra-uterine life and to arrested development. The causes of acquired club-foot are, in the order of their frequency: infantile paralysis, which allows the foot to be drawn out of place by the action of certain unopposed muscles; the various forms of spastic paralysis, which cause contraction of certain muscles or groups of muscles; the effects of scars from burns, lacerations, and deep-seated suppuration; and the results of certain injuries and diseases of the bone and joints.

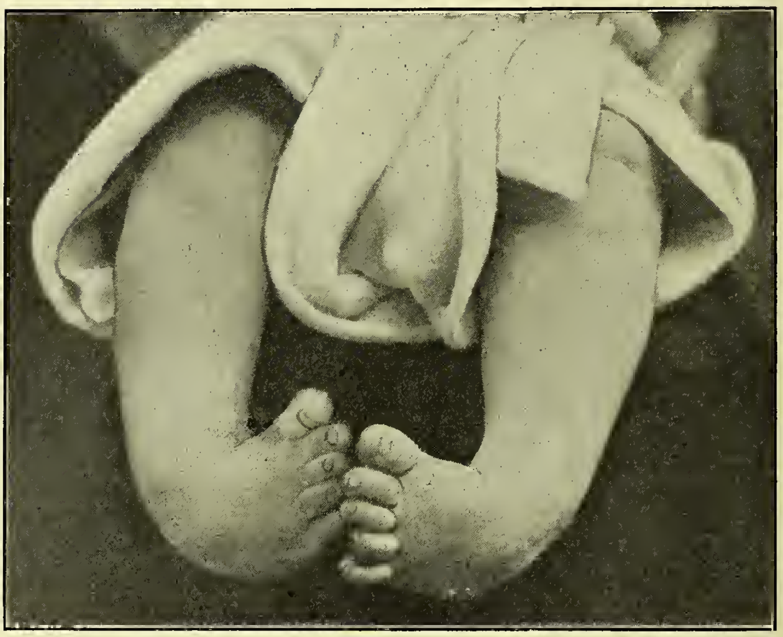
Talipes Equinovarus, or Congenital Club-foot.—This is by far the most frequent form of the affection, it being the deformity present in 77 per cent. of the congenital cases. It is often associated with spina bifida and other congenital malformations. The deformity consists in an inward dislocation of the anterior part of the foot at the mediotarsal articulation. With this there is also contraction of the plantar fascia, the Achilles tendon, and the tendons of the tibialis anticus and posticus muscles (Fig. 411). In the severest cases the bones are deformed and their normal relations changed.

In the acquired form of talipes equinovarus the disease is generally due to anterior poliomyelitis, and the deformity closely resembles the congenital form.

Talipes valgus is usually an acquired affection, and will be considered in the section devoted to Flat Foot.

Talipes equinus is occasionally seen as a congenital affection, but is much more common in the acquired form. In these cases it is due to paralysis of the anterior muscles of the leg, to contraction of the soleus and gastrocnemius, to a falling downward of the foot during long periods of recumbency, and as a compensatory lengthening of the limb after fracture and other conditions associated with shortening. The deformity consists in an extreme position of plantar flexion. The heel is elevated and the patient walks upon the distal extremities of the metatarsal bones (Fig. 412), or, in more marked cases, the toes may be flexed and their dorsal surfaces may be applied to the ground. Occasionally the deformity is associated with valgus or varus.

FIG. 411.



Congenital talipes equinovarus (club-foot). (Whitman.)

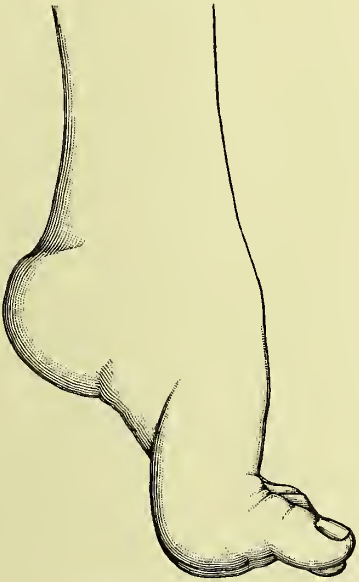
Talipes calcaneus is much rarer than the preceding. It is more common, however, as an acquired than as a congenital defect. It is frequently associated with a certain amount of inversion or eversion of the foot.

In this form the heel is depressed and the anterior portion of the foot elevated. The patient walks upon the heel.

Pes cavus is a term applied to an acute arching of the sole of the foot. This is often associated with the different varieties of talipes, and is the opposite of *pes planus*, or flat-foot.

The **treatment** of congenital club-foot should be inaugurated at the earliest possible moment. During the first few weeks after birth the nurse or mother should be taught to correct the deformity several times each day by gently pressing the foot into a normal position with the hands. At a later period the surgeon should attempt to overcorrect the deformity by manipulation, and to maintain the position thus obtained by the application of adhesive straps or a plaster-of-Paris cast in which a flat wooden sole has been imbedded. Persistent efforts by this method will result in a cure in the majority of cases.

Fig. 412.



Talipes equinus. (Lovett.)

If, however, the condition has been neglected until the soft tissues are less yielding, and the bones are firmer and deformed by walking, which always tends to increase the deformity, operative methods must be employed. These should be tried in the following order: First, forcible correction of the deformity, under general anæsthesia, by manipulation or by the use of various forms of apparatus, and the subsequent application of a plaster cast. Second, division of the tendo Achillis, with subsequent correction of the deformity by manipulation. Third, division of the tendons of the tibialis anticus or posticus. Fourth, incision of all the resisting structures on the inner side of the foot, down to the bone, the incision beginning just in front of and a little below the internal malleolus, and extending to the outer side of the neck of the astragalus (Phelps). Fifth, the removal of a wedge-shaped piece of bone from the outer side of the os calcis or astragalus, or removal of the entire astragalus.

In the early non-operative treatment of club-foot, and after any of the above mentioned operative procedures, the greatest care should be exercised to prevent a relapse. For this purpose the various kinds of club-foot shoes or braces will be found of value. A description of these may be found in any work on orthopedic surgery.

For the treatment of talipes equinus, division of the tendo Achillis is all that is required in the majority of cases.

In talipes calcaneus of paralytic origin, the tendo Achillis may be shortened, or the tendon of a functionally active muscle (as one of the peronei) may be grafted upon the tendo Achillis. Arthrodesis or removal of a portion of the articular cartilage from the astragalus, with a view to obtaining a firm anchylosis, has been recommended.

Flat Foot.

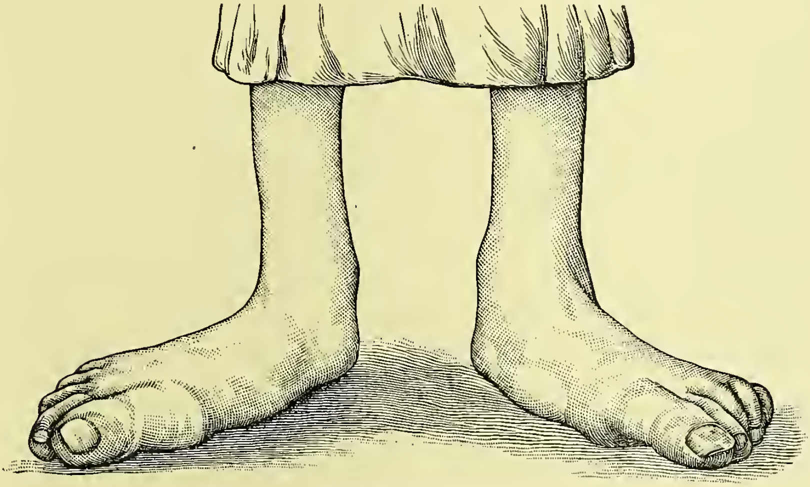
This condition, which is perhaps better spoken of as *weak foot,* is described by Lovett as an "abnormal condition where, on standing, the foot rolls over to the inside and the inner malleolus tends to become more prominent than it should." There are, in addition, a relaxation of the internal ligaments of the tarsus, a tendency to inward displacement of the astragalus, an abduction of the anterior portion of the foot, and a contraction of the muscles on the outer side of the leg. As a result of these changes there is a gradual lowering or breaking down of the antero-posterior arch, and the line of weight, which normally falls through the inner portion of the tarsus, passes to the inner side of the everted foot (Fig. 413).

The condition is encountered in childhood, but occurs most frequently in adolescence and young adults at a time when their occupations require constant standing or increased weight-bearing.

It is more frequent in females than in males, and is particularly common in fleshy individuals with small feet. The habit of walking or standing with the feet everted is perhaps the commonest cause of the trouble. As a result of this improper attitude the normal range of muscular action is restricted, the muscles become atrophied from relative disuse, and in standing the weight of the body is supported by the ligaments. As the ligaments on the inner aspect of the ankle are the ones which bear the greatest strain, they gradually become relaxed and the deformity is produced.

Badly-made shoes are undoubtedly responsible for a large number of cases of flat foot, the fault being that the shape of the shoe necessitates a crowding together of the toes. The deviation outward of the great toe deprives the foot of an important support, and diminishes the activity of the attached muscles in walking. Such shoes also cause corns and other sources of discomfort, and thereby favor an abnormal gait and improper attitudes in standing.

Fig. 413.



Flat foot. (Lovett.)

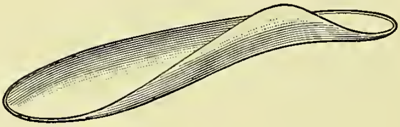
The **symptoms** of weak foot are apparent long before there is any noticeable breaking-down of the arch. They are at first only an unusual feeling of fatigue and moderate pain after exercise. The pain is generally referred to the inner side of the foot near the astragaloscaphoid articulation; but it may occur in the heel, at the base of the great toe, or in the calf or thigh. Examination at this period will generally show a foot habitually everted in walking, and if the feet are placed side by side the normal concavity along the first metatarsal bones is absent or may be replaced by convexity.

At a later period the internal malleolus becomes abnormally prominent and is depressed, the foot is rolled outward, and the arch is lowered. In the more exaggerated cases there is great eversion, and the inner margin of the sole is everywhere in contact with the floor, the displaced astragalus forms a prominence on the inner aspect of the foot, and in walking the knees are partly flexed and the foot is carried forward with an awkward gliding motion. The patient suffers constant pain on standing and walking, but is relieved by lying down. The first attempts at walking after rest are more painful from the fact that during rest the bones partly regain their normal relations. In these cases rigidity of the midtarsal joint is a characteristic sign. The patient is unable to invert the foot and passive motion is much restricted (Fig. 413).

Sufferers from this disorder, as far as possible, avoid walking and standing, and are often obliged to give up their former occupations. In a certain number of cases the deformity is present without symptoms, but in a very considerable number of cases the symptoms are well marked before appreciable lowering of the arch has occurred. When the arch is finally broken down there is little chance that improvement will take place except as a result of treatment.

Treatment.—In the presence of the earliest manifestations of the disease much may be done to prevent progress and relieve the suffering, by the wearing of well-constructed boots, by the avoidance of vicious habits of walking or standing, and by exercises which tend to strengthen the weakened muscles. The boot should have a straight inner border, should be of sufficient width to enable the toes to lie in their normal positions, and to allow the anterior transverse arch under the metatarsophalangeal joints to flatten out when the weight of the body is thrown on that foot. Slight inversion of the foot may be favored by making the inner margin of the sole and heel thicker than the outer. In walking, the foot should be held parallel with the antero-posterior diameter of the body, and this position should also be maintained in standing.

FIG. 414.



Flat-foot plate. (Lovett.)

Raising the body on the toes, the feet being parallel, will be found useful to strengthen the muscles. This should be regularly practised once or twice each day, the patient lifting the body in this manner from one to two hundred times. Massage, hot and cold douches, and general tonic measures will also be of value in this stage of the affection.

If the arch of the foot is broken down, it should be supported by the use of a steel supporter accurately fitted by being moulded on a plaster cast of the foot made while the position was corrected (Fig. 414). This steel supporter should be worn inside of a properly made shoe. In the severest cases, when great deformity is present, with marked rigidity, this should be forcibly corrected under general anæsthesia, the joint freely moved, and the foot encased in a plaster cast in an overcorrected position. At the end of three or four weeks the cast may be removed, and the patient allowed to walk about in a properly made shoe with the arch supported by a steel plate.

Hallux Valgus.

This condition, which consists in an outward deviation of the great toe, is fairly common in individuals past middle life. In the great majority of instances it is caused by an ill-fitting shoe which either compresses the toes or, by being too short, forces the prominent great toe to one side.

In extreme cases the toe may lie transversely across the other toes, in contact with their dorsal surfaces. This produces a subluxation of the metatarsophalangeal joint, the head of the metatarsal bone making a projection on the inner side of the foot, and by friction of the shoe may become enlarged by the growth of an exostosis. A bursa forms between the head of the bone and the soft parts, which may become inflamed, forming a *bunion.* This may suppurate, and give rise to a more or less extensive cellulitis of the foot, a suppurative arthritis, and occasionally osteomyelitis of the metatarsal bone.

In the suppurative condition just described, the **treatment** should consist in incision and drainage, with excision of the joint and removal of the dead bone if necessary.

In the non-suppurating conditions the end of the metatarsal bone should be excised, preferably by the method suggested by Fowler. This consists in making an incision between the first and second toes, opening the joint from the inside, strongly adducting the toe, and exposing the head of the metatarsal bone in the wound, removing the articular surface with bone-forceps or a saw, replacing the toe, and suturing the wound. After healing of the wound the toe should be maintained in proper position by a plantar splint of gutta-percha for several weeks.

Hammer-toe.

Hammer-toe is a contraction of the second, third, or fourth toe, resulting in an acute flexion of the second phalanx and generally full extension of the third. This condition is frequently accompanied by an irritable callosity over the summit of the flexed joint, and may be exceedingly painful. In the earlier stages the deformity may sometimes be corrected by the use of splints or tenotomy; in the latter stages, however, excision of the interphalangeal joint or amputation at the metatarsophalangeal joint is to be recommended.

Anterior Metatarsalgia.

This affection was first accurately described by Morton, of Philadelphia, and is often spoken of as *Morton's painful joint.* It consists in the occurrence of a severe and often spasmodic pain between the heads of the second and third, third and fourth, or fourth and fifth metatarsal bones. The pain usually comes on during walking, and is generally relieved by rest and removing the shoe. Exceptionally it occurs during rest, and may give rise to great suffering. It is often associated with weak foot, and has also been found to be accompanied by a breaking-down of the anterior transverse arch.

The **treatment** should consist in the wearing of properly made shoes which do not compress the toes, and, if the transverse arch is broken down or rigid, a support should be fitted to correct this deformity.

Club-hand.

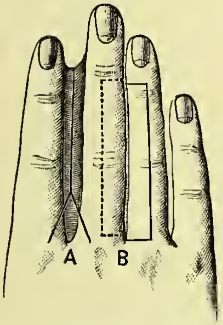
Club-hand is an exceedingly rare condition of the upper extremity analogous to club-foot in the lower. The deformity may or may not be associated with abnormalities of the bony skeleton. As a rule, the hand is deflected, either in flexion or extension, toward the radial or ulnar side of the forearm. It is not infrequently associated with other congenital malformations.

At an early period after birth the deformity may often be corrected by manipulation and fixation with splints. Tenotomy or osteotomy may be required, and amputation is occasionally indicated. The results of tenotomy in the hand are less satisfactory than in the lower extremity, for the reason that failure of union often occurs, with consequent impairment of motion.

Webbed Fingers (Syndactylism).

Webbed fingers is a congenital malformation in which two or more of the fingers are joined by either a thin cutaneous bridge or by a thick, fleshy mass. When the bridge is thin, it may be pierced at the base of the fingers and the opening allowed to heal, after which the thin bridge may be divided by scissors or a scalpel.

FIG. 415.



Webbed fingers. (Stimson.)

If the bridge is thick, two cutaneous flaps should be raised, one from the palmar surface of one finger and another from the dorsal surface of the adjoining digit. After these flaps are dissected free the bridge of tissue is removed and the exposed surface of each finger covered by wrapping it with its own cutaneous flap, which is trimmed to fill exactly the freshened area, and sutured in place (Fig. 415).

Supernumerary Fingers (Polydactylism).

Occasionally children are born with a complete or incomplete sixth digit. The malformation is frequently present in both hands. If useless or disfiguring, the extra finger should be removed. A similar condition is seen occasionally in the lower extremity.

Trigger-finger.

Trigger-finger is a condition in which the patient is able to close the fist, but on attempting to open it one finger remains for a fraction of a second flexed, and then flies open with a jerk, or is only opened by pressure of one of the other fingers, in which case it is extended in the same spasmodic manner.

The cause of the affection is some interference with the smooth and even gliding of the tendon in its sheath, as a small fibroma or other tumor. In a case operated upon by Lilienthal the cause of the trouble was found to be a minute cyst in the interior of the tendon-sheath.

The **treatment** should consist in opening the sheath and removal of the cause.

INDEX.

A.

Abdomen, cellulitis of, 422
  contusions of, 415
    diagnosis of, 416
    treatment of, 417
  diseases of, 422
  injuries of, 415
    extraperitoneal, 415
    intraperitoneal, 415
  wounds of, 418
    penetrating, 418
      symptoms of, 418
      treatment of, 420
Abdominal organs, actinomycosis of, 78
  wall, angioma of, 423
    dermoid cysts of, 423
    epithelioma of, 423
    fibroneuroma of, 423
    lipoma of, 423
    sarcoma of, 423
    tumors of, 423
Abnormalities of kidneys, congenital, 508
Abscess, 36
  acute, 39
  alveolar, 346
  appendicular, 473
  axillary, 379
  of bones, 651
  of brain, 287
  of chest-wall, 379
  chronic, 40
  ischiorectal, 633
  of kidney, 523
  of liver, 483
  of lungs, 384
  of parotid gland, 317
  perinephritic, 525
  peritonsillar, 345
  psoas, 687
    diagnosis of, from femoral hernia, 820
  retropharyngeal, 346, 687
  of spleen, 504
  submammary, 399, 400
  subpectoral, 379
  subperiosteal, 651
  subphrenic, 426
    appendicitis and, 482
Abscess of thorax, 379
A. C. E. mixture as general anæsthetic, 164
Acetonæmia, 120
Acid intoxication, 120
Acidosis, 120
  treatment of, 121
Acinous carcinoma of breast, 408
Acromegaly, 660
  symptoms of, 660
  treatment of, 660
Acromial end clavicle, dislocations of, 778
    downward, 778
    upward, 778
Acromion scapula, fractures of, 728
Actinomycosis, 75
  of abdominal organs, 78
  of bones, 658
  of brain, 79
  etiology of, 75
  of face, 76
  of intestines, 439
  of lungs, 388
  of neck, 76
  pathologic anatomy of, 76
  of peritoneum, 430
  of skin, 79
  symptoms of, 76
  of thorax, 77
  treatment of, 79
Actinomycotic ulcers of rectum, 637
Adams' forceps, 718
Adenitis, femoral, diagnosis of, from femoral hernia, 820
  inguinal, diagnosis of, from inguinal hernia, 817
Adenocarcinoma of rectum, 640
Adenocele, 405
Adenoid forceps, Curtis's, 342
  growths, 342
    treatment of, 342
Adenoma, 95
  of breast, 405
  of intestines, 456
  of kidneys, 534
  of liver, 486
  of palate, 349
  pathology of, 95
  of rectum, 639
  of scalp, sebaceous, 318

- Adenoma of testicle, 612
  - of thyroid gland, 326
  - of trachea, 361
- Adenomatous goitre, circumscribed, 326
  - diffuse, 325
- Adenopapilloma of breast, intracanalicular, 405
- Adrenal tumors, 537
  - symptoms of, 537
  - treatment of, 537
- Aërogenes capsulatus bacillus, 57
- Agglutinins, 31
- Aggressins, 26
- Ainhum, 184
- Alexins, 35
- Alveolar abscess, 346
- Ammonium urate calculi, 564
- Amputations, 836
  - at ankle-joint, 853
    - Syme's operation, 854
    - Pirogoff's operation, 854
    - Roux's operation, 854
  - of arm, 846
  - Brewer's rubber tourniquet in, 838
  - circular method of, 840
  - at elbow-joint, 846
  - of fingers, 843
  - of forearm, 845
  - general considerations of, 836
  - hæmostasis in, 837
  - at hip-joint, 849
  - interscapulothoracic, 847
  - at knee-joint, 851
    - bilateral flap operation, 851
    - Carden's method of, 852
    - Grittis' method of, 852
    - Stokes' method of, 852
  - of leg, 853
  - Lisfranc's, 854
  - at metatarsophalangeal joints, 855
  - method of making flaps in, 838
  - mid-tarsal, 854
  - osteoplastic, 838
  - racket-shaped method of, 842
  - at shoulder-joint, 846
    - deltoid flap method, 847
    - racket-shaped incision, 847
  - skin- and muscle-flap method of, 841
  - skin-flap method of, 840
  - stump after, treatment of, 856
  - at tarsometatarsal joint, 854
    - Hey's operation, 855
    - Skey's operation, 855
  - Teale's method of, 842
  - of thigh, 851
  - of toes, 855
  - in tuberculous arthritis, 686
    - of elbow, 698
- Amputations in tuberculous arthritis
    - of knee, 695
    - of shoulder, 698
    - of wrist, 698
  - at wrist, 845
- Anæsthesia, 155
  - colonic, 168
  - general, acute dilatation of stomach following, 162
    - diabetic coma following, 162
    - heart-weakness following, 162
    - late chloroform-poisoning following, 162
    - muscular paralysis following, 163
    - pulmonary irritation following, 162
  - local, 164
  - rectal, 168
    - ether vapor in, 168
  - Schleich's method of infiltration, 165
  - spinal, 166
    - cocaine in, 166
- Anæsthetics, 155
  - choice of, 163
  - general, 155
    - A. C. E. mixture, 164
    - anesthol, 164
    - chloroform, 159
    - complications arising from, 160
      - post-operative, from, 162
    - ether, 156
    - ethyl bromide, 163
      - chloride, 163
    - methyl chloride, 163
    - nitrous oxide, 156
    - somnoform, 163
  - local, cocaine, 165
    - ethyl chloride, 164
    - eucaine as, 166
    - ice, 164
    - kelene, 164
- Anastomosis of intestines, lateral, 470
    - by Murphy button, 468
  - of nerves, 274
- Anchylosis of joints, 699
- Anesthol as general anæsthetic, 164
- Aneurism, 199
  - of arteries of neck, 323
  - arteriovenous, 201
  - of bones, 666
  - cirsoid, 201
  - diagnosis of, 202
  - dissecting, 200
  - etiology of, 200
  - false, 113, 199
  - fusiform, 200
  - ligature in, distal, 208
    - proximal, 206

Aneurism, miliary, 201
    of renal artery, 514
    sacculated, 200
    traumatic, 201
    treatment of, 204
        acupuncture, 210
        galvanopuncture, 210
        gelatine, 211
    true, 199
    varicose, 201
Aneurismal varix, 201
Angina Ludovici, 316
        symptoms of, 316
        treatment of, 317
Angioma, 91
    of abdominal wall, 423
    of bladder, 571
    of kidneys, 534
    of liver, 486
    of neck, 323
    of œsophagus, 362
    pathology of, 91
    of pharynx, 362
    pulsating, 204
    of rectum, 639
    venous, 218
Ankle, dislocation of, 806
    tuberculous arthritis of, 695
Ankle-joint, amputation at, 853
        Pirogoff's operation, 854
        Roux's operation, 854
        Syme's operation, 854
Anthrax, 53
    etiology of, 53
    external, 53
    of face, 318
    internal, 53
    intestinal, 54
    œdema, malignant, 54
    prognosis of, 54
    respiratory, 54
    symptoms of, 53
    treatment of, 54
Antisepsis, 126
Antitoxins, 30
Antrum, empyema of, 338
    inflammations of, 338
        symptoms of, 338
        treatment of, 338
Anuria, calculous, 530
Anus, congenital malformations of, 631
    fissure of, 638
        symptoms of, 638
        treatment of, 638
    fistula of, 633
        diagnosis of, 634
        treatment of, 634
    imperforate, 631
Aorta, abdominal, ligation of, 226
Apoplexy, cerebral, 114
    pancreatic, 497
Appendectomy, intermuscular, 477
Appendicitis, 472
    acute catarrhal, 473
    diagnosis of, 475
    fecal fistula and, 483
    gangrenous, 473
    interstitial, 473
        operations for, 479
        perforative, 473
        sequelæ of, 482
    McBurney's operation for, 477
            point in, 474
    operations for, 477
    portal thrombosis and, 482
    subphrenic abscess and, 482
    symptoms of, 474
    treatment of, 477
        post-operative, 481
Appendicular abscess, 473
    colic, 472
Appendix, empyema of, 475
    inflammation of, 472
Arm, amputation of, 846
Arterial hemorrhage, 113
Arteries, ligation of, 220
        abdominal aorta, 226
        anterior tibial, 228
        axillary, 224
        brachial, 224
        common carotid, 222
            femoral, 227
            iliac, 226
        dorsalis pedis, 229
        external carotid, 222
            iliac, 227
        facial, 223
        gluteal, 227
        inferior thyroid, 224
        innominate, 222
        internal carotid, 223
            iliac, 227
        lingual, 223
        occipital, 223
        peroneal, 229
        popliteal, 228
        posterior tibial, 228
        radial, 225
        sciatic, 227
        subclavian, 223
        superficial femoral, 228
        superior thyroid, 223
        temporal, 223
        ulnar, 225
        vertebral, 224
    of neck, aneurisms of, 323
    renal, aneurism of, 514
Arteriovenous aneurism, 201
Arteritis, acute, 198
Arthritis, 676
    acute septic, 676
            symptoms of, 677
            treatment of, 677

- Arthritis, chronic non-tuberculous, 679
  - deformans, 680
    - symptoms of, 681
    - treatment of, 681
  - dry septic, 677
  - gonorrhœal, 678
    - treatment of, 679
  - gouty, 680
  - rheumatic, 680
  - rheumatoid, 680
  - syphilitic, 682
    - symptoms of, 682
    - treatment of, 682
  - tuberculous, 683
    - amputation in, 686
    - of ankle, 695
      - symptoms of, 695
      - treatment of, 695
    - arthrectomy in, 685
    - of elbow, 696
      - amputation in, 698
      - excision in, 697
      - symptoms of, 696
      - treatment of, 697
    - of hip-joint, 691. *See* Hip-disease.
    - of knee, 693
      - amputation in, 695
      - arthrotomy in, 694
      - excision in, 694
      - symptoms of, 693
      - treatment of, 694
        - Thomas's splint in, 694
    - prognosis of, 685
    - of shoulder, 696
      - amputation in, 698
      - excision in, 696
      - symptoms of, 696
      - treatment of, 696
    - symptoms of, 684
    - of tarsal bones, 696
    - treatment of, 685
    - of wrist, 697
      - amputation in, 698
      - excision of, 697
      - symptoms of, 697
      - treatment of, 697
- Arthrodesis of joints, 700
- Arthropathy, neuropathic, 681
- Arthrotomy in tuberculous arthritis of knee, 694
- Artificial limbs, use of, 856
- Ascites, chylous, 230
- Ascitic tuberculosis of peritoneum, 428
- Asepsis, 126
- Asthma, thymic, 123
- Astragalus, dislocations of, 808
    - forward, 808
    - inward, 808
    - outward, 808
- Astragalus, dislocations of, treatment of, 808
  - fractures of, 770
    - diagnosis of, 770
    - treatment, 771
  - removal of, 695
- Atheromatous endarteritis, 199
- Atlas of spine, dislocation of, 722
    - fractures of, 722
- Atony of bladder, 578
- Axillary abscess, 379
  - artery, 224
- Axis of spine, dislocation of, 722
    - fracture of, 722

B.

- Bacillus aërogenes capsulatus, 20, 43, 57
  - anthracis, 20, 43, 53
  - coli communis, 20, 22
  - diphtheria, 22
  - diplococcus lanceolatus, 22
  - of Friedländer, 22
  - gas, 57
  - mallei, 56
  - meningococcus, 22
  - proteins, 20, 22
  - pseudogonococcus, 24
  - pyocyaneus, 20, 22
  - smegma, 21
  - tetani, 20, 22
  - tuberculosis, 20, 64
- Bacteria, 17
  - action of, in body, 29
  - of genito-urinary tract, 24
  - of intestines, 23
  - of mouth, 22
  - of pharynx, 22
  - portals of entry of, 19
      - external, 19
      - internal, 22
  - of respiratory passages, 22
  - of skin, 20
  - of stomach, 23
- Bacterial excitant, 25, 26
  - host, 25, 28
  - infection, serotherapeutic measures in, 31
- Bacterinuria, 559
  - symptoms of, 560
  - treatment of, 560
- Bandage, figure-of-eight, 135
  - handkerchief, 140
  - many-tailed, 141
  - plaster-of-Paris, 143
  - roller, 135
  - spica, 136
  - spiral reversed, 135
  - T-, 140
  - triangular, 140
  - two-tailed jaw, 141

Bandage, Velpeau, 138
Bandaging, 134
Basal-celled epithelioma, 99
Bassini's operations for inguinal hernia, 824
Beck's operation for hypospadias, 580
Bed-sores, 63
Bell's palsy, 274
Bier's cups for hyperæmic treatment, 181
Bigelow's lithotrite, 566
Bilharzia hæmatobia, hæmaturia and, 561
Biliary colic, 491
Bilocular hydrocele, 602
Birth palsy, 275
Bladder, angioma of, 571
  atony of, 578
  calculus of, 564
    diagnosis of, 565
    in female, 571
    operations for, choice of, 570
    symptoms of, 564
    treatment of, 566
    varieties of, 564
  carcinoma of, 571
  congenital malformations of, 556
  contusions of, 553
  diseases of, 553
  diverticula of, 557
  double, 557
  epithelioma of, 571
  exstrophy of, 556
    treatment of, 556
  fibroma of, 571
  fibromyxoma of, 571
  foreign bodies in, 555
  functional affection of, 576
  implantation of, into ureter, 552
  inflammation of, 557
  injuries of, 553
  myoma of, 571
  neurosis of, 578
    treatment of, 579
  papilloma of, 571
  paralysis of, 577
  rupture of, 553
    extraperitoneal, 553
    intraperitoneal, 553
    symptoms of, 554
    treatment of, 554
  sarcoma of, 572
  trabeculated, 588
  tuberculosis of, 562
    symptoms of, 562
    treatment of, 563
  tumors of, 571
    diagnosis of, 572
    prognosis of, 573
    symptoms of, 572
    treatment of, 573
    villous, 571
Bladder, wounds of, 553
Blake's irrigating tube, 427
  operations for femoral hernia, 831
    for inguinal hernia, 829
    for umbilical hernia, 832
    for ventral hernia, 832
Blastomycetes, 79
Blastomycetic dermatitis, 79
Blastomycosis, 79
  pathology of, 79
  treatment of, 79
Bleeders, 114
Blood, transfusion of, direct, 150
Bloodgood's operations for inguinal hernia, 828
Bloodvessels, calcification of, media of, 199
  diseases of, 198
  fatty degeneration of, 199
  inflammation of, 198
Blum's experiments in shock, 107
Boil, 173
  symptoms of, 174
  treatment of, 174
Bone felon, 178
Bones, abscess of, 651
  actinomycosis of, 658
    treatment of, 658
  aneurism of, 666
  carcinoma of, 668
  caries of, 658
  chondroma of, 663
  cysts of, 664
    treatment of, 664
  diffuse periosteal thickening of, 659
  diseases of, 650
  endothelioma of, 666
    diagnosis of, 666
    prognosis of, 667
    treatment of, 667
  fibroma of, 663
  inflammations of, 650
    sequelæ of, 658
  lipoma of, 663
  myeloma of, 668
  necrosis of, 658
  nutritive disturbances of, 659
  osteoma of, 663
  Paget's disease of, 659
  sarcoma of, 664
    central, 665
    medullary, 665
    periosteal, 665
    peripheral, 665
  sclerosis of, 658
  syphilis of, 655
    symptoms of, 655
    treatment of, 656
  tuberculosis of, 656
    symptoms of, 656
    treatment of, 657

- Bones, tumors of, 663
- Bottini operation, 626
    - in senile hypertrophy of prostate gland, 622
- Bougies, bulbous, 588
  - olive-pointed, 590
- Bowels, constriction of, 447
  - ulcers of, 436. *See* Intestines, ulcers of.
- Bow-legs, 865
  - diagnosis of, 866
  - treatment of, 867
- Brachial artery, ligation of, 224
  - nerves, paralysis of, 275
- Bradford's bed-frame, 688
- Brain, abscess of, 287
    - treatment of, 288
  - actinomycosis of, 79
  - compression of, 283
    - prognosis of, 284
    - symptoms of, 284
    - treatment of, 284
  - concussion of, 280
    - symptoms of, 280
    - treatment of, 281
  - contusion of, 281
    - symptoms of, 282
    - treatment of, 282
  - diseases of, 280
  - inflammation of, 285
  - injuries of, 280
  - laceration of, 281
    - symptoms of, 282
    - treatment of, 282
  - membranes of, contusions of, 281
    - inflammation of, 285
    - laceration of, 281
  - motor areas of, 299
  - operations on, 301
  - protrusion of, 292
    - treatment of, 292
  - sinuses of, thrombosis of, 289
  - tumors of, 294
    - prognosis of, 297
    - symptoms of, 294
    - treatment of, 297
- Branchial cysts, 321
  - fistulæ, 320
- Breast, adenoma of, 405
    - diagnosis of, 406
    - treatment of, 407
  - adenopapilloma of, intracanalicular, 405
  - carcinoma of, 408
    - acinous, 408
    - diagnosis of, 411
    - duct, 408, 410
    - encephaloid, 409
    - prognosis of, 411
    - scirrhous, 409
    - symptoms of, 410
    - treatment of, 412
- Breast, cysto-adenoma of, 405
  - fibro-adenoma of, 405
  - fibrocysto-adenoma of, 405
  - fibroma of, intercanalicular, 405
  - hypertrophy of, diffuse virginal, 403
      - treatment of, 404
    - senile parenchymatous, 404
      - symptoms of, 404
  - inflammation of, 399
  - lupus of, 402
  - removal of, 413
  - sarcoma of, 407
    - diagnosis of, 407
    - treatment of, 408
  - syphilis of, 402
  - tuberculosis of, 402
    - treatment of, 403
  - tumors of, 405
- Brewer's rubber tourniquet in amputations, 838
- Bronchi, dilatation of, 386
    - symptoms of, 387
    - treatment of, 387
- Bronchiectasis, 386
  - symptoms of, 387
  - treatment of, 387
- Bronchoscope, Killian's, 355
- Bubo, chancroidal, 596
- Bubonocele, 815
- Bunion, 873
- Burns, 170
  - symptoms of, 170
  - treatment of, 171
- Bursæ, adventitious, 254
  - anatomical, 254
  - diseases of, 245, 253
  - inflammation of, 254
  - injuries of, 245
- Bursal cysts of neck, 323
- Bursitis, 254
  - acute, 254
    - symptoms of, 254
    - treatment of, 254
  - chronic, 254
    - symptoms of, 254
    - treatment of, 255
  - subacromial, 255
  - subdeltoid, 255
    - symptoms of, 255
    - treatment of, 255

C.

- CALCANEUM, fractures of, 770
    - diagnosis of, 770
    - treatment of, 771
- Calcium oxalate calculi, 564
  - phosphate calculi, 564
- Calculi, ammonium urate, 564
  - of bladder, 564
    - operations for, choice of, 570

Calculi, calcium oxalate, 564
    phosphate, 564
  cystine, 564
  of prostate gland, 617
  renal, 529
    causes of, 530
  ureteral, 542
  urethral, 593
  uric acid, 564
  xanthine, 564
Calculous anuria, 530
Cancer. *See* Carcinoma.
Cancer en cuirasse, 412
Cancrum oris, 63, 344
Capillary hemorrhage, 113
Carbolic gangrene, 62
Carbuncle, 175
  of face, 317
  of neck, 317
  symptoms of, 175
  treatment of, 175
Carcinoma, 95
  of bladder, 571
  of bones, 668
  of breast, 408
    acinous, 408
    duct, 408, 410
    encephaloid, 409
    scirrhous, 409
  colloidal, 96
  cylindric-celled, 98
  encephaloid, 98
  of gall-bladder, 493
  of intestines, 456
  of kidneys, 535
  of liver, 486
  of lungs, 390
  of lymph-nodes, 244
  of mediastinum, 391
  of œsophagus, 361
  of pancreas, 503
  pathology of, 95
  of pharynx, 361
  of prostate gland, 622
  of rectum, 640
  of salivary glands, 324
  scirrhous, 96
  of skin, 189, 192, 193
  spheroidal-celled, 96
  squamous-celled, 98
  of stomach, 443
  of testicle, 611
  of thyroid gland, 327
  of tongue, 348
  of trachea, 361
Carden's method of amputation at knee-joint, 852
Cardiac weakness, 121
Cardiospasm, 441
  symptoms of, 442
  treatment of, 442
Caries of bones, 658
Carotid artery, common, ligation of, 222
    external, ligation of, 222
    internal, ligation of, 223
Carpal bones, dislocations of, 794
    fracture of, 749
      symptoms of, 749
      treatment of, 749
Carpometacarpal articulation, dislocations of, 794
Cartilages, costal, fractures of, 725
  floating, 698
    symptoms of, 698
    treatment of, 698
  semilunar, dislocations of, 805
Catarrhal appendicitis, acute, 473
  pancreatitis, 499
Caseating tuberculosis of peritoneum, 428
Castration, 624
Catheter, flexible, 149
  Gouley's, 590
  Mercier's coudé, 149
  metallic, 149
  prostatic, 149
Catheterization, 148
Cauda equina, injuries to, 307
Cavernous angiomata, 91
  lymphangioma, 92
Cellulitis, 36, 176
  of abdomen, 422
  of face, 315
  gangrenous, 62
  mediastinal, acute, 391
  of mediastinum, 391
  of neck, 315
  of penis, 595
  of scalp, 316
  of scrotum, 595
  symptoms of, 176
  of tonsils, 345
  treatment of, 178
  varieties of, 177
Cephalalgia, traumatic, 293
Cerebral apoplexy, 114
  injuries of new-born, 293
  irritability, 282
  localization, 298
  palsy, infantile, 293
Cerebrospinal meningitis, epidemic, 286
Cervical lymph-nodes, tuberculosis of, 235
  sympathetic nerve, resection of,
      for exophthalmic goitre, 274
    for glaucoma, 274
  vertebræ, dislocation of, 722
    fractures of, 722
Chancre, 69
  of penis, 596
Chancroid, 596

Chancroid, phagedenic, 596
treatment of, 596
Chancroidal bubo, 596
ulcers of rectum, 637
Charcot's disease of joints, 681
Cheever's lateral pharyngotomy, 352
Chemotaxis, 34
Chest-binder, 142
Chest-wall, abscess of, 379
contusions of, 377
treatment of, 377
osteoplastic resection of, 395
tumors of, 380
wounds of, 378
treatment of, 378
Chimney-sweeps' cancer, 599
Chismore's evacuator, 567
Chloroform as general anæsthetic, 159
Chloroform-poisoning, 120
following general anæsthesia, 162
Cholangitis, 491
symptoms of, 491
treatment of, 492
Cholecystectomy, 495
Cholecystenterostomy, 497
Cholecystitis, 491
symptoms of, 491
treatment of, 492
Cholecystostomy, 495
Cholecystotomy, 494
Choledochotomy, 496
Cholelithiasis, 488
diagnosis of, 490
symptoms of, 488
treatment of, 491
Chondrodystrophia, 661
Chondroma, 86
of bones, 663
pathology of, 86
of ribs, 380
of spinal cord, 308
of thorax, 380
of trachea, 361
Chorion epithelioma, 101
pathology of, 101
of testicle, 612
Chylangioma, 92
Chylothorax, 230, 382
treatment of, 230
Chylous ascites, 230
treatment of, 230
hydrocele, 604
Cicatrization, 38
Circular enterorrhaphy, 466
method of amputation, 840
Circulatory ulcers of skin, 185
Circumscribed fractures of skull, 714
Cirsoid aneurism, 201
Clavicle, dislocations of, 777
acromial end, dislocations of, 778
diagnosis of, 778
downward, 778
Clavicle, acromial end, dislocations of, treatment of, 779
upward, 778
fractures of, 730
complications of, 731
sternal end, dislocations of, 777
diagnosis of, 777
treatment of, 777
Clavus, 183
Cleft palate, 332
operations for, 332
treatment of, 332
varieties of, 333
Club-foot, 867
congenital, 867
treatment of, 869
Club-hand, 874
Cocaine as local anæsthetic, 165
in spinal anæsthesia, 166
Coin catcher, 357
Colic, appendicular, 472
biliary, 491
Collapse, 108
Colles' fracture, 745
complications of, 746
diagnosis of, 746
prognosis of, 747
treatment of, 747
Colloid carcinoma, 96
goitre, 325
Colon bacillus, acute osteomyelitis and, 650
Colonic anæsthesia, 168
Colostomy, 471
inguinal, 471
Compression of brain, 283
of nerves, 261
Concussion of brain, 280
of spinal cord, 304
Condylomata, 71
Congenital abnormalities of kidneys, 508
absence of urethra, 579
malformations of anus, 631
club-foot, 867
dislocation of hip, 860
diagnosis of, 860
treatment of, 861
Hoffa's method, 861
Lorenz's method, 861
diverticula of intestines, 452
hydrocele, 602
idiopathic dilatation of stomach, 433
inguinal hernia, 813
malformations of bladder, 556
of rectum, 631
rickets, 661
spastic paralysis, 293
stricture of rectum, 631
umbilical fistulæ, 422

Congenital umbilical hernia, 821
Constriction of bowel, 447
Contusions of abdomen, 415
  of bladder, 553
  of brain, 281
  of chest-wall, 377
  of face, 312
  of joints, 669
  of muscles, 245
  of neck, 312
  of nerves, 257
  of penis, 595
  of scalp, 312
  of scrotum, 595
  of skin, 172
  of spinal cord, 304
  of testicle, 606
  of thorax, 377
  of urethra, 581
Cord, hydrocele of, 602
Corns, 183
  treatment of, 183
Coronoid process, fractures of, 742
      symptoms of, 742
      treatment of, 742
Cortical osteomyelitis, subacute, 654
Costal cartilages, fractures of, 725
Coxa valga, 863
  vara, 861
    symptoms of, 862
    treatment of, 862
Cranial topography, 299
    auditory area, 301
    higher psychical area, 300
      visual area, 301
    lower cortical visual area, 301
    motor area, 300
      speech area, 300
    stereognostic area, 300
Craniectomy, linear, 294
Craniotomy, 301
  osteoplastic, 302
Cretinism, 325
Crile's experiments in shock, 107
Cryoscopy, 545
Cryptogenetic infections, 42
Curette, Gottstein's, 342
Curtis's adenoid forceps, 342
Curvature of spine, rotary lateral, 857
Cushing purse-string operations for femoral hernia, 831
Cylindric-celled carcinoma, 98
Cystic goitre, 326
  hygroma, 234
  lymphangioma, 92
Cystine calculi, 564
Cystitis, 557
  diagnosis of, 558
  symptoms of, 558
  treatment of, 559
Cysto-adenoma of breast, 405
Cysts, 102
  of abdominal wall, dermoid, 423
  of bones, 664
  branchial, 321
  classification of, 102
  degeneration, 103
  dental, 349
  dermoid, 105
  extravasation, 103
  exudation, 102
  hydatid, 104
  implantation, 104
  of intestines, 456
  of kidneys, dermoid, 534, 536
    echinococcus, 536
    serous, 536
  of liver, hydatid, 485
  of lungs, echinococcus, 390
  of mediastinum, dermoid, 391
    echinococcus, 391
  of mesentery, 456
  of mouth, 347
  mucous, 103
  of neck, 321
    bursal, 323
    hemorrhagic, 323
  ovarian, 105
  of pancreas, 502
  parasitic, 103
  pathology of, 103
  of rectum, dermoid, 639
  retention, 103
  of scalp, dermoid, 318
    sebaceous, 318
  of scrotum, dermoid, 598
    sebaceous, 598
  sebaceous, 103
    of skin, 190
  serous, 103
  of skin, dermoid, 191
  of spleen, 505
  of suprarenal glands, 537
  thyroglossal, 321
  of ureters, 545
  varieties of, 102

D.

Dactylitis, syphilitic, 656
  tuberculous, 657
Decapsulation of kidney in nephritis, 537, 538
Deciduoma, pathology of, 100
Decortication of lung, 396
Deformities of ear, 374
Degeneration cysts, 103
  of joints, pulpy, 683
Delirium tremens, 124
    fractures and, 707
    prognosis of, 124
    symptoms of, 124
    treatment of, 125

Dental cysts, 349
Dermatitis, 173
  x-ray, 173
    treatment of, 173
Dermoid cysts, 105
    of abdominal wall, 423
    of kidneys, 534, 536
    of mediastinum, 391
    ovarian, 105
    of rectum, 639
    of scalp, 318
    of scrotum, 598
    of skin, 191
Diabetic coma following general anæsthesia, 162
  gangrene, 63
Diaphragmatic hernia, 824
Dilatation of bronchi, 386
  lymphatic, 234
  of pylorus, digital, 460
    instrumental, 460
  of stomach, acute, following anæsthesia, 162
Diphtheria, bacillus of, 22
Diplococcus lanceolatus, 20, 22
Dislocations, 772
  of ankle, 806
  of astragalus, 808
    forward, 808
    inward, 808
    outward, 808
  of bones of hand, 795
  of carpal bones, 794
  causation of, 773
  of clavicle, 777
    acromial end, 778
        downward, 778
        upward, 778
    sternal end, 777
  complete, 772
  compound, treatment of, 775
  diagnosis of, 773
  double, 772
  of elbow, 789
    backward, 790
    external, 790
    forward, 790
    internal, 790
    lateral, 790
    mixed, 790
  of ensiform, 783
  of fibula, 806
  of hip, 796
    classification of, 798
    complications of, 801
    congenital, 860
      treatment of, 861
        Hoffa's method, 861
        Lorenz's method, 861
    iliac, 798
    infracotyloid, 800
Dislocations of hip, perineal, 800
    pubic, 798
    sciatic, 798
    supracotyloid, 800
    thyroid, 798
  incomplete, 772
  of jaw, 776
  of knee, 803
    backward, 803
    complete, 803
    forward, 803
    incomplete, 803
    lateral, 803
    rotary, 804
  of manubrium sternum, 782
  mediotarsal, 808
  of metacarpal bones, 794
  metacarpophalangeal, 795
  of metatarsal bones, 809
  multiple, 772
  old treatment of, 775
  of os magnum, 794
  of patella, 802
    inward, 802
    outward, 802
    by rotation, 802
  pathologic, 772
    anatomy of, 773
  of phalanges of foot, 809
    of hand, 795
  of phalanx of thumb, 795, 796
  of radius, 790, 792
  of ribs, 783
  of semilunar bone, 794
    cartilages, 805
  of shoulder, 783
    complications of, 785
    incomplete, 784
    intracoracoid, 784
    McBurney's hook in, 789
    old, reduction of, 788
    reduction of, by extension, 786
      Kocher's method of, 786
    subclavicular, 784
    subcoracoid, 784
    subglenoid, 784
    subspinous, 785
    supracoracoid, 785
  of spine, 779
    atlas, 722
    axis, 722
    bilateral, 780
    cervical vertebræ, 722
    dorsal vertebræ, 722
    unilateral, 780
  spontaneous, 772
  of sternum, 782
  of stomach, acute, 432
    congenital idiopathic, 433
  subastragaloid, 807
    backward, 808

Dislocations, subastragaloid, inward, 808
    outward, 808
  symmetric, 772
  of tarsal bones, 809
  of tendons, 248
  tibiotarsal, 806
    backward, 807
    forward, 807
    outward, 807
    upward, 807
  traumatic, 772
  treatment of, 774
  of ulna, 790
  of wrist, 793
    carpometacarpal articulation, 794
    inferior radio-ulnar articulation, 793
    mediocarpal articulation, 794
    radiocarpal articulation, 793
Dissection, aneurism, 200
Diverticula of bladder, 557
  of intestines, acquired, 452
    congenital, 452
  of œsophagus, 360
  of sigmoid, 454
    symptoms of, 454
    treatment of, 455
Diverticulitis, acute, 452
    treatment of, 453
Dorsal vertebræ, dislocation of, 722
    fractures of, 722
Dorsalis pedis artery, ligation of, 229
Drainage, cigarette, 144
  tube, glass, 144
Dressings, wet, 144
  wound, 143, 144
Duct carcinoma of breast, 408, 410
  papilloma, 94
Duodenotomy, 497
Duodenum, ulcer of, 434
    prognosis of, 435
    symptoms of, 435
    treatment of, 436
Dupuytren's contraction, 252
    treatment of, 253
  splint, 769
Dura, inflammation of, 285
Dysenteric ulcerations of intestines, 437

E.

Ear, deformities of, 374
  diseases of, 374
  furuncles of, 375
  hæmatoma of, 375
  inflammations of, 375
Eastlander's operation for empyema, 394
Ecchymoses, 114
Echinococcus cysts of kidneys, 536
    of lungs, 390
    of mediastinum, 391
    of spleen, 505
Ectopic liver, 483
  spleen, 504
  testicle, 605
Edebohl's incision for exposure of kidney, 547
Eisemann's experiments in shock, 107
Elbow, dislocations of, 789
    backward, 790
    complications of, 792
    diagnosis of, 790
    external, 790
    forward, 790
    internal, 790
    lateral, 790
    mixed, 790
    treatment of, 792
  miner's, 256
  tuberculous arthritis of, 696
      amputation in, 698
      excision in, 697
Elbow-joint, amputation at, 846
Elephantiasis, 232
  symptoms of, 233
  treatment of, 234
Embolism, ischæmic gangrene and, 61
Emphysema of antrum, 338
  of appendix, 475
  of lungs, 382
  operation for, Eastlander's, 394
    Fowler's, 396
    Frederich's, 395
    Schede's, 395
Emphysematous gangrene, 57
Empyema of lungs, 389
Encephalitis, 287
Encephalocele, 291
  treatment of, 292
Encephaloid carcinoma, 98
    of breast, 409
Endarteritis, chronic, 198
    atheromatous, 199
    obliterative, 199
  syphilitic, 71
Endoscope, Otis', 586
Endothelioma, 90
  of bones, 666
  of lungs, 390
  pathology of, 90
  of salivary glands, 324
  of spinal cord, 308
  of spleen, 505
  of thorax, 380
Ensiform, dislocations of, 783
Enterectomy, 466
Enteric intussusception, 447
Enterocele, 810
Entero-epilocele, 810
Enterolith, 431

Enterorrhaphy, circular, 466
    Maunsel's method of, 469
Enterotomy, 466
Enucleation of tonsils, 343
        Mathew's operation for, 343
Epidemic cerebrospinal meningitis, 286
Epididymectomy, 624
Epididymio-vasostomy, 624
Epididymis, gonorrhœa of, 609
    inflammation of, 607
    operations on, 624
    syphilis of, 609
        diagnosis of, 609
        treatment of, 610
Epididymitis, acute, 607
        symptoms of, 607
        treatment of, 607
Epilepsy, 294
    focal, 293
        prognosis of, 293
        treatment of, 293
    Jacksonian, 293
    traumatic, 292
        prognosis of, 293
        treatment of, 293
Epilocele, 810
Epiphyseal separations, fractures of humerus, 738
Epiphysitis, acute, 654
Epispadias, 581
Epistaxis, 114, 336
    treatment of, 336
Epithelial odontoma, 349
Epithelioma, 98
    of abdominal wall, 423
    basal-celled, 99
    of bladder, 571
    of face, 323
    of larynx, 361
    of lip, 323
    of nasopharynx, 344
    of nose, 344
    of œsophagus, 361
    pathology of, 98
    of penis, 598
    of pharynx, 361
    of rectum, 640
    of scrotum, 599
    sebaceous, 99
    of skin, 188
    of tongue, 348
    of ureters, 545
    of urethra, 593
Epulis, 349
Ergot gangrene, 62
Erysipelas, 45
    etiology of, 45
    of face, 314
    morbid anatomy of, 45
    of neck, 315
    neonatorum, 45
Erysipelas, prognosis of, 46
    symptoms of, 45
    treatment of, 46
Erysipeloid, 46
    symptoms, 46
    treatment, 47
Ether, as general anæsthetic, 156
    vapor in rectal anæsthesia, 168
Ethmoiditis, 338
Ethyl bromide as general anæsthetic, 163
    chloride as general anæsthetic, 163
        as local anæsthetic, 164
Eucaine as local anæsthetic, 166
Exophthalmic goitre, 325
        resection of cervical sympathetic nerve for, 274
Exostoses, 87
    of spinal cord, 308
Exstrophy of bladder, 556
Extracapsular fractures of femur, 751
Extradural hemorrhage of spinal cord, 305
Extraperitoneal injuries of abdomen, 415
    rupture of bladder, 553
Extravasation cysts, 103
Exudation cysts, 102
Eyeball, sarcoma of, 324

F.

Face, actinomycosis of, 76
    anthrax of, 318
        treatment of, 318
    carbuncle of, 317
        treatment of, 317
    cellulitis of, 315
        treatment of, 316
    contusions of, 312
    diseases of, 312
    epithelioma of, 323
        treatment of, 323
    erysipelas of, 314
        treatment of, 315
    inflammations of, 314
    injuries of, 312
    lipoma of, 322
    lupus of, 329
    malignant pustule of, 318
            treatment of, 318
    tumors of, 318
    wounds of, 313
Facial artery, ligation of, 223
    nerves, paralysis of, 274
False aneurisms, 113, 199
Farcy, 55
    acute, 56
    buds, 56
    chronic, 56
Fasciæ, diseases of, 245

- Fasciæ, injuries of, 245
  - tuberculosis of, 252
    - treatment of, 252
- Fat-embolism, 123
  - fractures and, 706
  - symptoms of, 124
  - treatment of, 124
- Fatty degeneration of bloodvessels, 199
- Fecal fistula, appendicitis and, 483
- Felon, bone, 178
- Femoral adenitis, diagnosis of, from femoral hernia, 820
  - artery, common, ligation of, 227
    - superficial, ligation of, 228
  - hernia, 811, 818
    - diagnosis of, 820
      - from femoral adenitis, 820
      - from psoas-abscess, 820
      - from saphenous varix, 820
    - operations for, 830
      - Blake's, 831
      - Cushing's purse-string, 831
    - symptoms of, 819
- Femur, condyles of, fractures of, 762
      - symptoms of, 762
      - treatment of, 762
    - T-fracture into joint, 762
        - prognosis of, 763
        - symptoms of, 762
        - treatment of, 763
  - epiphysis of, fractures of, 762
      - symptoms of, 762
      - treatment of, 762
  - fractures of, 751
    - diagnosis of, 752
    - extracapsular, 751
    - intracapsular, 751
    - prognosis of, 753
    - treatment of, 755
      - apparatus for, 757
      - Hodgen's splint in, 758
      - operative, 763
      - Philip's splint in, 759
      - Whitman's method, 756
  - head of, fractures of, 751
  - lower extremity of, fractures of, 762
  - neck of, fractures of, 751
  - shafts of, fractures of, 759
      - diagnosis of, 760
      - prognosis of, 761
      - treatment of, 761
  - trochanters of, fractures of, 751
- Fibro-adenoma of breast, 405
- Fibrocystic disease of testicle, 612
- Fibrocysto-adenoma of breast, 405
- Fibroma, 84
  - of bladder, 571
- Fibroma of bones, 663
  - of breast, intercanalicular, 405
  - durum, 84
  - of intestines, 456
  - of kidneys, 534
  - of larynx, 361
  - of mediastinum, 391
  - molle, 84
  - molluscum, 191
  - of muscles, 249
  - of neck, 323
  - of nerves, 270
  - pathology of, 84
  - of rectum, 639
  - of spinal cord, 308
  - of trachea, 361
- Fibromyxoma of bladder, 571
- Fibroneuroma of abdominal wall, 423
  - of neck, 323
  - of nerves, 270
  - of skin, 191
- Fibrous goitre, 326
  - odontoma, 350
  - polypus, 341
- Fibula, dislocations of, 806
  - fractures of, 767
    - diagnosis of, 767
    - prognosis of, 768
    - treatment of, 768
- Fifth nerve, neurectomy of, 264, 265
- Figure-of-eight bandage, 135
- Filaria medinensis, 184
  - sanguinis hominis, hæmaturia and, 561
- Fingers, amputations of, 843
  - supernumerary, 875
  - trigger, 251
  - webbed, 874
- Finney's method of pyloroplasty, 460
- Fissure of anus, 638
- Fissured fractures of skull, 714
- Fistula, 40
  - branchial, 320
  - congenital umbilical, 422
  - fecal appendicitis and, 483
  - in ano, 633
    - diagnosis of, 634
    - treatment of, 634
  - thyroglossal, 321
- Flat foot, 870
    - symptoms of, 871
    - treatment of, 872
- Floating cartilage, 698
  - kidney, 516
- Foamy organs, 57
- Focal epilepsy, 293
- Follicular odontoma, 349
  - prostatitis, 615
- Foot, flat, 870
  - fractures of, 770
    - diagnosis of, 770
    - treatment of, 771

Foot, perforating ulcer of, 273
        treatment of, 273
    weak, 870
Forceps, Adams', 718
    adenoid, Curtis', 342
Forearm, amputation of, 845
    fractures of, 741
    shaft of, fractures of, 743
            complications of, 744
            diagnosis of, 743
            treatment of, 744
Foreign bodies in bladder, 555
        in intestines, 431, 448
        in larynx, 354
        in nose, 336
        in œsophagus, 355
        in stomach, 431
        in trachea, 354
Fowler's operation for empyema, 396
    position for peritoneal drainage, 427
Fracture, 701
    of astragalus, 770
    of both bones of leg, 766
    of calcaneum, 770
    of carpal bone, 749
    of clavicle, 730
        complications of, 731
        diagnosis of, 731
        prognosis of, 731
        treatment of, 731
    Colles', 745
        complications of, 746
    comminuted, 701
    complications of, 705
    compound, 701
        treatment of, 711
    of coronoid process, 742
    of costal cartilages, 725
            diagnosis of, 726
            prognosis of, 726
            treatment of, 726
    depression, 701
    diagnosis of, 702
    delirium tremens and, 707
    double, 701
    dressings for, 710
    etiology of, 701
    fat-embolism and, 706
    of femur, 751
        condyles of, 762
            T-fracture into joint, 762
        epiphysis of, 762
        extracapsular, 751
        head of, 751
        intracapsular, 751
        lower extremity of, 762
        neck of, 751
        shaft of, 759
        treatment of, 755
            apparatus for, 757
            Hodgen's splint in, 758
Fracture of femur, treatment of,
            Phelp's splint in, 759
            Whitman's method, 756
        trochanters of, 751
    of fibula, 767
    of foot, 770
    of forearm, 741
    gangrene and, 707
    green-stick, 701
    hæmatoma and, 707
    of humerus, 732
        complications of, 739
        epiphyseal separations, 738
        external condyle, 738
        lower extremity of, 737
            diagnosis of, 737
        shaft of, 736
            diagnosis of, 736
            treatment of, 736
        upper extremity of, 733
            complications of, 734
            diagnosis of, 733
            prognosis of, 734
            treatment of, 734
    ischæmic paralysis and, 705
            prognosis of, 706
            symptoms of, 706
            treatment of, 706
    longitudinal, 701
    of lower extremity of radius, 742
        jaw, 720
            symptoms of, 720
            treatment of, 720
        leg, 766
    of malar bone, 719
    of metacarpal bones, 750
    of metatarsal bones, 770
    multiple, 701
    muscular weakness and, 707
    of nasal bones, 718
            symptoms of, 718
            treatment of, 718
    oblique, 701
    old, 701
    of olecranon, 741
    paralysis and, 707
    of patella, 763
    of pelvis, 726
        diagnosis of, 726
        treatment of, 728
    of phalanges of foot, 770
        of hand, 750
    Potts', 767
    pseudo-arthrosis and, 707
    punch, 750
    recent, 701
    repair of, 702
    of ribs, 725
        diagnosis of, 726
        prognosis of, 726
        treatment of, 726

Fracture of scaphoid, 749
  of scapula, 728
    acromion, 728
      diagnosis of, 728
      treatment of, 728
    body of, 729
      diagnosis of, 729
      treatment of, 729
    coracoid, 730
      diagnosis of, 730
      treatment of, 730
    glenoid, 729
      diagnosis of, 729
      treatment of, 730
    neck of, 729
      diagnosis of, 729
      treatment of, 730
    spine of, 729
      diagnosis of, 729
      treatment of, 729
  separation at epiphyseal line, 701
  of shaft of forearm, 743
      complications of, 744
  simple, 701
  single, 701
  of skull, 714
    circumscribed, 714
    fissured, 714
    prognosis of, 715
    symptoms of, 716
    treatment of, 717
  of spinal cord, 306
  of spine, 721
    atlas of, 722
    axis of, 722
    cervical vertebræ, 722
    dorsal vertebræ, 722
    symptoms of, 722
    treatment of, 723
  spiral, 701
  splints for, 709
  of sternum, 724
    diagnosis of, 725
  stiffness of joints and, 707
  of superior maxilla, 719
  of tarsal bones, 770
  of tibia, 766, 767
  transverse, 701
  traumatic aneurism and, 707
  treatment of, general, 708
  T-shaped, 701
  united, 701
  ununited, 701
  V-shaped, 701
  of wrist, 745
    complications of, 746
  of zygoma, 719
Fracture-box, 709
Fracture-dislocation, 772
  of spine, 722
Frambœsia, 184
Frazier-Lentz hot-air apparatus, 675
Frederich's operation for empyema, 395
Freudenberg-Bottini incisor, 626
Friedländer, bacillus of, 22
Frontal sinus, inflammation of, 339
      treatment of, 339
Frost-bite, ischæmic gangrene and, 61
Functional affection of bladder, 576
Furuncle, 173
  of ear, 375
Fusiform aneurism, 200

G.

Galactocele, 401
  treatment of, 401
Gall-bladder, carcinoma of, 493
    diagnosis of, 493
    symptoms of, 493
    treatment of, 494
  hydrops of, 489
  inflammation of, 491
  operations on, 494
  tumors of, 493
Gall-ducts, operations on, 494
  tumors of, 493
Ganglion, 251
  compound palmar, 251
  treatment of, 251
Gangrene, 38, 58
  carbolic, 62
  diabetic, 63
  dry, 58
  emphysematous, 57
  ergot, 62
  etiology of, 58
    exciting, 58
    predisposing, 58
  fractures and, 707
  inflammatory, 62
  ischæmic, 61
    embolism and, 61
    frost-bite and, 61
    ligation and, 61
    thrombosis and, 61
  of lungs, 387
  moist, 58
  pre-senile, 61
  senile, 60
    sclerosis and, 60
  symptoms of, 59
  traumatic, 62
  treatment of, 60
Gangrenous appendicitis, 473
  cellulitis, 62
  pancreatitis, 498
  stomatitis, 344
Gas bacillus, 57
Gasserian ganglion, removal of, in neuralgia, 266
Gastrectomy, 464
  partial, 460

Gastric ulcer, 434. *See* Stomach, ulcer of.
Gastro-enterostomy, 464
 McGraw's method of, 465
Gastro-intestinal tract, tuberculosis of, 438
Gastro-mesenteric ileus, 432
Gastrostomy, 464
Gastrotomy, 459
Genital organs, operations on, 624
 tract, removal of, 625
Genito-urinary tract, bacteria of, 24
Gigli saw, 303
Glanders, 55
 acute, 56
 chronic, 56
 diagnosis of, 56
 etiology of, 56
 morbid anatomy of, 55
 symptoms of, 56
 treatment of, 57
Glandular hypospadias, 579
Glaucoma, resection of cervical sympathetic nerve for, 274
Glénard's disease, 483
Glenoid scapula, fractures of, 729
Glioma, 91
 pathology of, 91
Gliosarcomata, 89
Glossitis, 344
 chronic superficial, 345
 symptoms of, 345
 treatment of, 345
Glottis, œdema of, 354
  treatment of, 354
Gluteal artery, ligation of, 227
 hernia, 824
Goitre, 324
 adenomatous, circumscribed, 326
  diffuse, 325
 colloid, 325
 cystic, 326
 exophthalmic, 325
  resection of cervical sympathetic nerve for, 274
 fibrous, 326
 hyperplastic, 325
 parenchymatous, 325
Goltz's experiments in shock, 106
Gonococcus, 43
Gonorrhœa of epididymis, 609
Gonorrhœal arthritis, 678
Gottstein's curette, 342
Gouley's catheter, 590
 tunnelled sound, 590
Gouty arthritis, 680
Gravel, 530
Green-stick fractures, 701
Gritti's method of amputation at knee-joint, 852
Guinea-worm, 184
Gumma of liver, 487
Gumma of lungs, 389
 of lymph-nodes, 241
 of palate, 350
 of pharynx, 350
 of spinal cord, 308
 of tongue, 350
 of tonsils, 350
Gummata, 71
Gummatous ulcerations, 71
Gums, sarcoma of, 349
 tumors of, 349

H.

Hæmangioma, 91
Hæmatemesis, 114
Hæmatoma of ear, 375
 fractures and, 707
 of scalp, 312
Hæmatomata, 113
Hæmatomyelia, 305
 prognosis of, 305
 symptoms of, 305
 treatment of, 305
Hæmatonephrosis, 541
Hæmaturia, 114, 560
 bilharzia hæmatobia and, 561
 filaria sanguinis hominis and, 561
 treatment of, 562
Hæmophilia, 114
Hæmoptysis, 114
Hæmostasis in amputations, 837
Hæmothorax, 378
Hallux valgus, 873
  treatment of, 873
Halsted's operations for inguinal hernia, 827
Hammer-toe, 874
Hand, bones of, dislocations of, 795
Handkerchief bandage, 140
Harelip, 329
 double, 330
 operations for, 331
 single, 329
 treatment of, 330
Head, diseases of, 312
 injuries of, 312
 tumors of, 318
Heart, diseases of, 196
 rupture of, 196
 valvular disease of, 121
 weakness of, following general anæsthesia, 162
 wounds of, 196
  symptoms of, 197
  treatment of, 197
Heat-prostration, 122
 treatment of, 123
Hematocele, 595
Hematogenous kidney, infections of, 518
Hemorrhage, 113

Hemorrhage, arterial, 113
    capillary, 113
    false aneurisms due to, 113
    hæmatomata due to, 113
    intermediate, 113
    of nose, 336
    of pancreas, 497
    primary, 113
    recurrent, 113
    secondary, 113
    of spinal cord, 304
    symptoms of, 114
    traumatic, 113
        external, 113
        internal, 113
        subcutaneous, 113
    treatment of, 114
        acupressure in, 117
        digital pressure in, 116
        elevation in, 116
        hot water in, 116
        hyperflexion in, 116
        ice in, 116
        ligature in, 116
        mechanical compression in, 116
        styptics in, 116
        sutures in, 117
        torsion in, 117
    venous, 113
Hemorrhagic cysts of neck, 323
    pancreatitis, 498
Hemorrhoids, 644. *See* Piles.
    diagnosis of, 645
    symptoms of, 644
    treatment of, 645
        radical, 646
        Whitehead's, 648
Hepatic ducts, inflammation of, 492
Hereditary syphilis, 73
Herpes progenitalis, 595
        treatment of, 596
Hernia, 810
    cerebri, 292
        treatment of, 292
    diaphragmatic, 824
    fatty, of linea alba, 822
    femoral, 811, 818
        diagnosis of, 820
            from femoral adenitis, 820
            from psoas abscess, 820
            from saphenous varix, 820
        operations for, 830
            Cushing's purse-string, 831
            Blake's, 831
        symptoms of, 819
        treatment of, 820
    gluteal, 824
    incarcerated, 811
Hernia, incomplete, 815
    infantile, 813
    inflamed, 811
    inguinal, 811, 812
        congenital, 813
        diagnosis of, 816
            differential, 817
            from hydrocele, 817
            from inguinal adenitis, 817
            from varicocele, 817
        direct, 813
        oblique, 813
        operations for, 824
            Bassini's, 824
            Blake's, 829
            Bloodgood's, 828
            Halsted's, 827
            Kocher's, 829
        symptoms of, 815
        treatment of, 817
    interstitial, 823
    irreducible, 811
    Littré's, 819
    lumbar, 811, 824
    of muscles, 246
    obstructed, 811
    obturator, 811
    operative treatment of, 824
    perineal, 811
    properitoneal, 823
    reducible, 811
    Richter's, 819
    sciatic, 111, 824
    scrotal, 815
    sliding, 815
    of spinal cord, 309
    strangulated, 812
        operations for, 833
    of testicle, 606
    umbilical, 811, 820
        congenital, 821
        operations for, 832
            Blake's, 832
            Mayo's, 833
        signs of, 821
        symptoms of, 821
        treatment of, 822
    ventral, 811, 822
        operations for, 832
            Blake's, 832
            Mayo's, 833
        treatment of, 822
Hey's operation, amputation at tarsometatarsal joint, 855
Hip, dislocations of, 796
        classification of, 798
        complications of, 801
        congenital 860
            diagnosis of, 860
            treatment of, 861
                Hoffa's method, 861

- Hip, dislocations of, congenital, treatment of, Lorenz's method, 861
    - diagnosis of, 798
    - iliac, 798
        - diagnosis of, 799
    - infracotyloid, 800
    - perineal, 800
    - prognosis of, 801
    - pubic, 798
        - diagnosis of, 799
    - sciatic, 798
        - diagnosis of, 799
    - supracotyloid, 800
    - thyroid, 798
        - diagnosis of, 799
    - treatment of, 801
  - excision of, 693
- Hip-disease, 691
  - symptoms of, 691
  - treatment of, 692
    - Thomas' splint in, 692
    - Whitman's splint in, 692
- Hip-joint, amputation at, 849
  - tuberculous arthritis of, 691. *See* Hip-disease.
- Hirschsprung's disease, 433
- Hodgen's splint in treatment of fractures of femur, 758
- Hodgkin's disease, 242
    - symptoms of, 242
    - treatment of, 243
- Hoffa's method in treatment of congenital dislocation of hip, 861
- Horse-hair probang, 357
- Hour-glass stomach, 442
    - treatment of, 442
- Housemaid's knee, 256
    - treatment of, 256
- Humerus, fractures of, 732
    - complications of, 739
    - epiphyseal separations, 738
    - external condyle, 738
    - lower extremity of, 737
    - shaft of, 736
    - treatment of, 739
        - operative, 741
    - upper extremity of, 733
        - complications of, 734
- Hydatid cysts, 104
    - of liver, 485
- Hydatiform mole, 101
- Hydrocele, 601
  - bilocular, 602
  - chylous, 604
  - congenital, 602
  - of cord, 602
  - diagnosis of, from inguinal hernia, 817
  - double, 602
  - of neck, 322
  - treatment of, 604
- Hydrocephalus, 290
  - external, 290
  - internal, 290
  - treatment of, 290
- Hydro-encephalocele, 292
  - treatment of, 292
- Hydronephrosis, 541, 542
  - intermittent, 542
  - symptoms of, 542
  - treatment of, 542
- Hydrophobia, 51
  - etiology of, 51
  - morbid anatomy of, 52
  - symptoms of, 52
  - treatment of, 52
    - Pasteur, 53
- Hydrops articulorum, 673
  - of gall-bladder, 489
- Hydrothorax, 381
  - symptoms of, 381
  - treatment of, 382
- Hygroma, cystic, 234
  - of neck, 322
- Hypernephroma, 101
  - of kidneys, 535
  - pathology of, 102
  - of suprarenal glands, 537
- Hyperplasia of lymph-nodes, 241
- Hyperplastic goitre, 325
  - tuberculosis of intestines, 438
- Hyperthyroidism, 325
- Hypertrophy of breast, diffuse virginal, 403
    - senile parenchymatous, 404
  - of prostate gland, senile, 618
      - Bottini operation in, 622
      - catheterism in, 621
  - senile, of prostate gland, prostatectomy in, 622
  - of spleen, 506
    - treatment of, 506
- Hypodermoclysis, 154
- Hypospadias, 579
  - glandular, 579
  - penoscrotal, 579
  - perineal, 579
  - treatment of, 580
- Hysteria, diagnosis of, concussion of spinal cord from, 304

I.

- Ice as local anæsthetic, 164
- Idiocy, 294
- Idiopathic, congenital, dilatation of stomach, 433
  - multiple hemorrhagic sarcoma, 193
  - osteomyelitis, acute, 650
- Ileocæcal intussusception, 447

Ileocæcal tuberculosis, 438
        symptoms of, 438
        treatment of, 438
Ileocolic intussusception, 447
Ileus, gastromesenteric, 432
Iliac artery, common, ligation of, 226
        external, ligation of, 227
        internal, ligation of, 227
    dislocation of, 798
Imbecility, 294
Immunity, 30
    active, 31
    cellular, 30
    humoral, 30
    passive, 32
Imperforate anus, 631
Implantation cysts, 104
Incontinence of urine, 578
Indigo-carmine test in operations on kidneys, 546
Infantile cerebral palsy, 293
    hernia, 813
    paralysis, 279
Infective granulomata, 38
Inferior radio-ulnar articulation, dislocations of, 793
Inflammations, 33
    acute, 33
        loss of function in, 34
        pain in, 34
        redness in, 34
        swelling in, 34
        symptoms of, 33
            local, 33
            general, 34
        temperature in, 34
    of antrum, 338
    of appendix, 472
    of bladder, 557
    of bloodvessels, 198
    of bones, 650
    of brain, 285
    of breast, 399
    of bursæ, 254
    causes of, 33
    chronic, 38
        causes of, 38
        symptoms of, 38
    of dura, 285
    of ear, 375
    of epididymis, 607
    of face, 314
    of frontal sinus, 339
    of gall-bladder, 491
    of hepatic ducts, 492
    of joints, 672
    of kidney, 517
    of lymph-channels, 231
    of lymph-nodes, 231
    of mammary gland, 399
    of mediastinum, 391
    of mouth, 344
Inflammations of muscles, 248
    of neck, 314
    of nerves, 261
    of nose, 337
    of pancreas, 498
    of parotid gland, 317
    of penis, 595
    of peritoneum, 423
    of pia, 285
    of prostate gland, 614
    of rectum, 632
    of salivary glands, 346
    of scalp, 316
    of scrotum, 595
    of seminal vesicle, 613
    of skin, 173
    of sphenoidal sinus, 340
    of tendons, 249
    of testicle, 608
    of tongue, 344
    of tonsils, 345
    of ureters, 540
    of urethra, 583
Infracotyloid dislocation, 800
Ingrowing toe-nails, 182
Inguinal adenitis, diagnosis of, from inguinal hernia, 817
    colostomy, 471
    hernia, 811, 812
        congenital, 813
        direct, 813
        diagnosis of, 816
            differential, 817
            from hydrocele, 817
            from inguinal adenitis, 817
            from varicocele, 817
        oblique, 813
        operation for, 824
            Bassini's, 824
            Blake's, 829
            Bloodgood's, 828
            Halsted's, 827
            Kocher's, 829
Innominate artery, ligation of, 222
Interacinar pancreatitis, 501
Intercanalicular fibroma of breast, 405
Interlobular pancreatitis, 501
Intermediate hemorrhage, 113
Intermittent hydronephrosis, 542
Intermuscular appendectomy, 477
Interscapulothoracic amputation, 847
Interstitial appendicitis, acute, 473
    hernia, 823
    mastitis, chronic, 400
    pancreatitis, 499
Intestinal anastomosis by Murphy button, 468
    anthrax, 54
    obstruction, 447
        acute, 447
            symptoms of, 448

Intestinal obstruction, acute, treatment of, 449
    chronic, 450
        symptoms of, 451
        treatment of, 451
Intestines, actinomycosis of, 439
    diagnosis of, 439
  adenoma of, 456
  bacteria of, 23
  carcinoma of, 456
  cysts of, 456
  diseases of, 431
  diverticula of, acquired, 452
    congenital, 452
  dysenteric ulcerations of, 437
      treatment of, 438
  fibroma of, 456
  foreign bodies in, 431, 448
      symptoms of, 431
      treatment of, 431
  lateral anastomosis of, 470
  lipoma of, 456
  myoma of, 456
  obstruction of, 447. *See* Intestinal obstruction.
  operations on, 459
  papilloma of, 456
  sarcoma of, 457
  tuberculosis of, 438
    hyperplastic, 438
  tumor of, 456
    symptoms of, 457
    treatment of, 458
  typhoid perforation of, 437
      prognosis of, 437
      symptoms of, 437
      treatment of, 437
  ulcers of, 436
Intoxication, acid, 120
Intracanalicular adenopapilloma of breast, 405
Intracapsular fractures of femur, 751
Intracoracoid dislocation of shoulder, 784
Intracranial neurectomy in neuralgia, 266
Intramedullary hemorrhage of spinal cord, 305
Intraperitoneal injuries of abdomen, 415
  rupture of bladder, 553
Intravenous infusion of normal salt solution, 153
Intubation of larynx, 366
Intussusception, 447
  colic, 447
  enteric, 447
  ileocæcal, 447
  ileocolic, 447
Ischæmic gangrene, 61
  paralysis, fractures and, 705
Ischiorectal abscess, 633
    symptoms of, 633
    treatment of, 633

J.

Jaws, diseases of, 344
  dislocation of, 776
    diagnosis of, 776
    treatment of, 777
  lower, removal of, 353
  operations on, 350
  osteomyelitis of, 346
    diagnosis of, 347
    treatment of, 347
  sarcoma of, 349
  tumors of, 349
  upper, removal of, 353
Joint mice, 680
  painful, Morton's, 874
Joints, anchylosis of, 699
  arthrodesis of, 700
  Charcot's disease of, 681
      symptoms of, 681
      treatment of, 681
  contusions of, 669
  diseases of, 669
  inflammations of, 672
  injuries of, 669
  pulpy degeneration of, 683
  sprains of, 669
    symptoms of, 669
    treatment of, 670
  stiffness of, fractures and, 707
  wounds of, 671
    symptoms of, 671
    treatment of, 672
Jury mast, 690

K.

Kelene as local anæsthetic, 164
Kelly's proctoscope, 636
Keloid, 192
  treatment of, 192
Keyes' urethral syringe, 586
Kidney, abscess of, 523
    symptoms of, 523
    treatment of, 524
  adenoma of, 534
  angioma of, 534
  calculus of, 529. *See* Renal calculus.
  carcinoma of, 535
  congenital abnormalities of, 508
  cysts of, dermoid, 534, 536
    echinococcus, 536
    serous, 536
  decapsulation of, in nephritis, 537, 538
  diseases of, 508
  exposure of, 547

Kidney, exposure of, oblique lumbar incision, 547
    posterior vertical incision, 547
  fibroma of, 534
  floating, 516
  hematogenous infections of, 518
  hypernephroma of, 535
  inflammations of, 517
  injuries of, 508, 510
    subparietal, 510, 511
      prognosis of, 512
      symptoms of, 510
      treatment of, 512
  lipoma of, 534
  movable, 514
    prognosis of, 516
    symptoms of, 516
    treatment of, 516
  myxoma of, 534
  operations on, 545
    cryoscopy in, 545
    indigo-carmine test in, 546
    methylene-blue test in, 546
    phloridzin test in, 546
    separation of urines in, 545
  palpable, 516
  papilloma of, 534
  polycystic, 536
  sarcoma of, 535
  syphilis of, 526
    symptoms of, 526
    treatment of, 526
  tuberculosis of, 527
    course of, 527
    diagnosis of, 528
    prognosis of, 529
    symptoms of, 528
    treatment of, 529
  tumors of, 534
    symptoms of, 535
      hæmaturia, 535
      pain, 536
      tumor, 535
    treatment of, 536
    urine in, 536
  wounds of, open, 510, 513
Killian's bronchoscope, 355
Knee, dislocations of, 803
    backward, 803
    complete, 803
    diagnosis of, 804
    forward, 803
    incomplete, 803
    lateral, 803
    prognosis of, 804
    rotary, 804
    treatment of, 804
  housemaid's, 256
  tuberculous arthritis of, 693
      amputation in, 695
      arthrotomy in, 694
      excision in, 694
Knee-joint, amputation at, 851
      bilateral flap operation, 851
      Carden's method of, 852
      Gritti's method of, 852
      Stokes' method of, 852
Knock-knee, 863
  diagnosis of, 863
  treatment of, 863
Kocher's method of reduction of dislocation of shoulder, 786
  operations for inguinal hernia, 829
König's spiral canula, 365

L.

Laceration of brain, 281
Laminectomy, 311
Laryngectomy, 367
Larynx, diseases of, 354
  epithelioma of, 361
  fibroma of, 361
  foreign bodies in, 354
      treatment of, 355
  intubation of, 366
  operations on, 363
  papilloma of, 361
  syphilis of, 363
  tuberculosis of, 363
  tumors of, 361
    diagnosis of, 362
    treatment of, 362
  wounds of, 314
Lateral anastomosis of intestines, 470
  lithotomy, 570
Leg, amputation of, 853
  both bones of, fractures of, 766
  lower, fractures of, 766
  varicose veins of, 213
Leiomyoma, 92
Leontiasis, 660
  treatment of, 660
Leptomeningitis, acute septic, 286
      prognosis of, 287
      symptoms of, 286
      treatment of, 287
Leucocytes, 34
  action of, 35
Leukæmia, lymphatic, 243
Ligation of arteries, 220
Ligature knots, 145
    flat, 145
    granny, 145
    reef, 145
    surgeon's, 145
Ligatures, 145
Lingual artery, ligation of, 223
Lip, epithelioma of, 323
    treatment of, 323
Lipoma, 85
  of abdominal wall, 423
  of bones, 663

Lipoma of face, 322
  of intestines, 456
  of kidneys, 534
  of mediastinum, 391
  of muscles, 249
  of neck, 322
  of œsophagus, 362
  pathology of, 85
  of pharynx, 362
  of rectum, 639
  of scalp, 322
  of scrotum, 598
  of spinal cord, 308
  of trachea, 361
Lisfranc's amputation, 854
Lithotomy, lateral, 570
  median, 569
  suprapubic, 567
Lithotrite, Bigelow's, 566
Littré's hernia, 819
Liver, abscess of, 483
    symptoms of, 484
    treatment of, 484
  adenoma of, 486
  angioma of, 486
  carcinoma of, 486
  cysts of, hydatid, 485
      treatment of, 486
  diseases of, 483
  ectopic, 483
  gumma of, 487
  operations on, 494
  resection of, 494
  sarcoma of, 486
  tumors of, 486
    symptoms of, 486
    treatment of, 486
Lockjaw, 47
Lorenz's method in treatment of congenital dislocation of hip, 861
Lumbar hernia, 811, 824
  puncture, 311
Lungs, abscess of, 384
    prognosis of, 386
    symptoms of, 384
    treatment of, 386
  actinomycosis of, 388
    symptoms of, 388
    treatment of, 388
  carcinoma of, 390
  decortication of, 396
  diseases of, 377
  echinococcus cysts of, 390
      prognosis of, 390
      symptoms of, 390
      treatment of, 390
  emphysema of, 389
  empyema of, 382
    symptoms of, 383
    treatment of, 384
  endothelioma of, 390
  gangrene of, 387
Lungs, gangrene of, prognosis of, 387
      symptoms of, 387
      treatment of, 387
  gumma of, 389
  injuries of, 377
  sarcoma of, 390
  tuberculosis of, 388
  tumors of, 390
Lupus of breast, 402
  of face, 329
Lymphadenitis, 231
  chronic, 241
Lymphadenoma, benign, 241
  malignant, 242
Lymphangioma, 91
  cavernous, 92
  cystic, 92
Lymphangiomata, 234
Lymphangitis, 231
  symptoms of, 231
  treatment of, 231
Lymphatic dilatations, 234
  leukæmia, 243
  nævi, 92, 234
  system, diseases of, 230
      injuries of, 230
  telangiectasis, 92
Lymph-channels, diseases of, 231
  inflammation of, 231
  injuries of, 230
  obstruction of, 231
Lymph-nodes, carcinoma of, 244
  cervical, tuberculosis of, 235
  diseases of, 231
  gumma of, 241
  hyperplasia of, 241
  inflammation of, 231
  sarcoma of, 244
  syphilis of, 241
  tuberculosis of, 235
      prognosis of, 237
      symptoms of, 236
      treatment of, 239
Lymphœdema, 232
Lymphosarcoma, 244
  of spleen, 505
Lymphosarcomata, 89
Lysins, 30

M.

McBurney's hook in dislocation of shoulder, 789
  operation for appendicitis, 477
  point in appendicitis, 474
McGraw's method of gastro-enterostomy, 465
Mackenzie's tonsillotome, 343
Macrocheilia, 235
  treatment of, 235
Macrodactylia, 235
  treatment of, 235

Macroglossia, 235
    treatment of, 235
Macular syphilide, 70
Madura foot, 183
Malar bone, fractures of, 719
Malformations of anus, congenital, 631
    of bladder, congenital, 556
    of rectum, congenital, 631
    of urethra, 579
Malignant œdema, 54
        prognosis of, 55
        symptoms of, 55
        treatment of, 55
    pustule, 53
        of face, 318
Mammary gland, diseases of, 399
        inflammation of, 399
Manubrium sternum, dislocations of, 782
Many-tailed bandage, 141
Marjolin's ulcers, 188
Mastitis, acute, 399
        symptoms of, 399
        treatment of, 400
    chronic, 400
        diagnosis of, 401
        interstitial, 400
        treatment of, 401
Mastoiditis, 375
    treatment of, 376
Maunsel's method of enterorrhaphy, 469
Maxilla, superior, fractures of, 719
            symptoms of, 719
            treatment of, 719
Mayo's method of pylorectomy, 462
    operations for umbilical hernia, 833
        for ventral hernia, 833
    varicose vein enucleator, 217
Median lithotomy, 569
Mediastinal cellulitis, acute, 391
            symptoms of, 391
            treatment of, 391
    thoracotomy, anterior, 396
Mediastinum, carcinoma of, 391
    cellulitis of, 391
    cysts of, dermoid, 391
        echinococcus, 391
    diseases of, 390
    fibroma of, 391
    inflammation of, 391
    lipoma of, 391
    sarcoma of, 391
    tumors of, 391
        symptoms of, 391
        treatment of, 391
Mediocarpal articulation, dislocations of, 794
Mediotarsal dislocations, 808
Medullary sarcoma of bones, 665
Melæna, 114
Melanosarcomata, 90
Meningitis, 285
    cerebrospinal, epidemic, 286
Meningocele, 291, 309
    treatment of, 292, 300
Meningococcus, 22
Meningomyelocele, 309
    treatment of, 310
Mesentery, cysts of, 456
Metacarpal bones, dislocations of, 794
        fractures of, 750
            diagnosis of, 750
            treatment of, 750
Metacarpophalangeal dislocations, 795
Metatarsal bones, dislocations of, 809
            diagnosis of, 809
            treatment of, 809
        fractures of, 770
            diagnosis of, 770
            treatment of, 771
Metatarsalgia, anterior, 874
        treatment of, 874
Metatarsophalangeal joints, amputation at, 855
Methyl chloride as general anæsthetic, 163
Methylene-blue test in operations on kidneys, 546
Micrococcus gonorrhœæ, 20
    tetragenus, 22
Mid-tarsal amputation, 854
Miliary aneurism, 201
Miner's elbow, 256
        treatment of, 256
Moles, 191
    hydatidiform, 101
Morbus coxæ, 691. *See* Hip disease.
Morison's operation for ascites of cirrhosis of liver, 487
Morton's painful joint, 874
            treatment of, 874
Mouth, bacteria of, 22
    cysts of, 347
        treatment of, 348
    diseases of, 344
    floor of, removal of, von Langenbeck's operation for, 352
    inflammation of, 344
    operations on, 350
    tumors of, 347
Movable kidney, 514
Mucous cysts, 103
    tubercles, 71
Multiple neuritis, 261
Murphy button, intestinal anastomosis by, 468
Muscles, contusions of, 245
    diseases of, 245
    fibroma of, 249
    hernia of, 246
        false, 246
        treatment of, 246

Muscles, inflammation of, 248
  injuries of, 245
  lipoma of, 249
  rupture of, 245
    diagnosis of, 245
    treatment of, 246
  sarcoma of, 249
  tumors of, 249
    treatment of, 249
  wounds of, 246
Muscular paralysis following general anæsthesia, 163
  weakness, fractures and, 707
Mycetoma, 183
Myelocele, 310
  prognosis of, 310
  treatment of, 310
Myeloma, 87
  of bones, 668
  pathology of, 87
Myoma, 92
  of bladder, 571
  of intestines, 456
  of œsophagus, 362
  pathology of, 92
  of pharynx, 362
Myositis, 248
  ossificans, 248
  treatment of, 248
Myxœdema, 325, 327
Myxoma, 86
  of kidneys, 534
  pathology of, 86
  of rectum, 639
  of spinal cord, 308

N.

Nævus, 218
  lymphatic, 92, 234
Nasal bones, fractures of, 718
  polypus, 340
    treatment of, 340
Nasopharyngeal polypus, 341
    symptoms of, 341
    treatment of, 341
Nasopharynx, diseases of, 335
  epithelioma of, 344
  papilloma of, 344
  sarcoma of, 344
  tumors of, 340
Neck, actinomycosis of, 76
  angioma of, 323
  arteries of, aneurisms of, 323
  carbuncle of, 317
    treatment of, 317
  cellulitis of, 315
    treatment of, 316
  contusions of, 312
  cysts of, 321
    bursal, 323
    hemorrhagic, 323
Neck, diseases of, 312
  erysipelas of, 315
  fibroma of, 323
  fibroneuroma of, 323
  hydroceles of, 322
  hygroma of, 322
  inflammations of, 314
  injuries of, 312
  lipoma of, 322
  sarcoma of, 324
  scrofuloderma of, 329
  tumors of, 318
  wounds of, 313
Necrosis of bones, 658
Negri bodies, 52
Nephrectomy, 549
Nephritis, decapsulation of kidney in, 537, 538
  surgical treatment of, 537, 538
Nephrolithotomy, 548
Nephropexy, 549
Nephrotomy, 548
Nerve or nerves, anastomosis of, 274
  brachial, paralysis of, 275
  cervical sympathetic, resection of, for exophthalmic goitre, 274
      for glaucoma, 274
  compression of, 261
  contusions of, 257
    symptoms of, 257
    treatment of, 257
  diseases of, 257
  facial, paralysis of, 274
  fibroma of, 270
  fibroneuroma of, 270
  fifth, neurectomy of, 264, 265
  inflammation of, 261
  injuries of, 257
  stretching of, 263
    in sciatica, 263
  suture of, 260
  tumors of, 270
    treatment of, 271
  wounds of, 257
    symptoms of, 258
    treatment of, 259
Neuralgia, 262
  diagnosis of, 263
  etiology of, 262
  injection methods in, 266
  neurectomy in, 264
    intracranial, 266
  neurotomy in, 264
  removal of Gasserian ganglion in, 266
  treatment of, 263
Neurasthenia, traumatic, diagnosis of concussion of spinal cord from, 304
Neurectomy of fifth nerve, 264, 265
  in neuralgia, 264
    intracranial, 266

Neuritis, 261
  multiple, 261
  symptoms of, 261
  treatment of, 262
Neuroma, 93
Neuropathic arthropathy, 681
    symptoms of, 681
    treatment of, 682
Neuroses of bladder, 578
Neurotomy in neuralgia, 264
Newborn, cerebral injuries of, 293
Nipple, Paget's disease of, 403
Nitrous oxide as general anæsthetic, 156
Noma, 63
Nose, deformities of, 335
  destruction of, 335
  diseases of, 335
  epithelioma of, 344
  foreign bodies in, 336
  hemorrhage of, 336
    treatment of, 336
  inflammations of, 337
  papilloma of, 344
  sarcoma of, 344
  tumors of, 340

O.

Obliterative endarteritis, 199
Obturator hernia, 811
Occipital artery, ligation of, 223
Odontoma, 87, 345
  composite, 350
  epithelial, 349
  fibrous, 350
  follicular, 349
    compound, 350
  radicular, 350
O'Dwyer's intubation instruments, 367
Œdema of glottis, 354
Œsophagotomy, external, 374
Œsophagus, angioma of, 362
  carcinoma of, 361
  diseases of, 354
  diverticula of, 360
    symptoms of, 360
    treatment of, 360
  epithelioma of, 361
  foreign bodies in, 355
      symptoms of, 355
      treatment of, 356
  lipoma of, 362
  myoma of, 362
  operations on, 363
  sarcoma of, 362
  stricture of, 357
    symptoms of, 359
    treatment of, 359
  tumors of, 361
    diagnosis of, 362
Œsophagus, tumors of, treatment of, 362
Oidii, 79
Oidiomycosis, 79
Olecranon, fractures of, 741
    diagnosis of, 742
    treatment of, 742
Operations for acute appendicitis, 477, 479
  Bottini, 626
  on brain, 301
  for calculus of bladder, choice of, 570
  for carcinoma of prostate gland, 629
  for cleft palate, 332
  for empyema, Estlander's, 394
    Fowler's, 396
    Frederich's, 395
    Schede's, 395
  on epididymis, 624
  for femoral hernia, 830
      Blake's, 831
      Cushing purse-string, 831
  on gall-bladder, 494
  on gall-ducts, 494
  on genital organs, 624
  for harelip, 331
  for inguinal hernia, 824
      Bassini's, 824
      Blake's, 829
      Bloodgood's, 828
      Halsted's, 827
      Kocher's, 829
  on intestines, 459
  on jaws, 350
  on kidneys, 545
  on larynx, 363
  on liver, 494
  on mouth, 350
  on œsophagus, 363
  on penis, 624
  on pharynx, 350, 363
  preparation of dressings for, 130
    of instruments for, 128
    of nurses for, 127
    of operator for, 127
    of patient for, 127
    of room for, 131
    of suture for, 128
  on prostate glands, 626
  on spinal cord, 308, 310
  on spleen, 507
  on stomach, 459
  for strangulated hernia, 833
  on thorax, 392
  on thyroid gland, 327
  on tongue, 350
  on trachea, 364
  for umbilical hernia, 832
      Blake's, 832
      Mayo's, 833

- Operations on ureters, 545
  - for ventral hernia, 832
    - Blake's, 832
    - Mayo's, 833
- Operative hernia, treatment of, 824
- Opsonins, 30
- Orchitis, 608
  - symptoms of, 608
  - syphilitic, 609
  - treatment of, 609
- Orcho-epididymitis, 608
- Os magnum, dislocation of, 794
- Osteitis, 650
  - deformans, 659
    - symptoms of, 660
    - treatment of, 660
- Osteochondritis, 682
  - syphilitic, 75, 656
- Osteogenesis imperfecta, 661
- Osteoma, 87
  - of bones, 663
  - pathology of, 87
  - of ribs, 380
- Osteomalacia, 661
  - symptoms of, 661
  - treatment of, 661
- Osteomyelitis, acute, 650
    - colon bacillus and, 650
    - idiopathic, 650
    - non-traumatic, 650
    - pneumonococcus and, 650
    - staphylococcus pyogenes aureus and, 650
    - streptococcus and, 650
    - symptoms of, 651
    - traumatic, 650
    - treatment of, 652
    - typhoid bacillus and, 650
  - albuminosa, 654
    - treatment of, 654
  - chronic, 654
  - of jaws, 346
  - of ribs, 379
  - subacute, 654
    - cortical, 654
      - symptoms of, 654
      - treatment of, 654
  - typhoid, 654
    - symptoms of, 654
    - treatment of, 655
- Osteoplastic amputations, 838
  - craniotomy, 302
  - resection of chest-wall, 395
  - thoracotomy, 397
- Osteotome, 864
- Otis' endoscope, 586
  - urethrometer, 588
- Otis-Wyeth urethrotome, 592
- Otitis media, 375
    - symptoms of, 375
    - treatment of, 376
- Ovarian dermoids, 105

P.

- Pachymeningitis, acute external, 285
  - chronic internal, 286
- Paget's disease of bones, 659
    - of nipple, 403
      - treatment of, 403
- Palate, adenoma of, 349
  - cleft, 332
  - gumma of, 350
  - removal of, von Langenbeck's operation for, 352
  - sarcoma of, 349
  - tumors of, 349
- Palpable kidney, 516
- Palsy, birth, 275
  - facial, 274
  - infantile cerebral, 293
- Pancreas, carcinoma of, 503
    - diagnosis of, 503
    - symptoms of, 503
    - treatment of, 503
  - cysts of, 502
    - symptoms of, 502
    - treatment of, 502
  - diseases of, 497
  - hemorrhage of, 497
    - symptoms of, 497
    - treatment of, 498
  - inflammation of, 498
  - tumors of, 503
- Pancreatic apoplexy, 497
- Pancreatitis, acute, 498
    - symptoms of, 499
    - treatment of, 500
  - catarrhal, 499
    - symptoms of, 499
  - chronic, 499, 501
    - symptoms of, 501
    - treatment of, 501
  - gangrenous, 498
    - symptoms of, 500
  - hemorrhagic, 498
  - interacinar, 501
  - interlobular, 501
  - interstitial, 499
  - parenchymatous, 499
  - suppurative, 498
    - symptoms of, 500
- Papilloma, 93
  - of bladder, 571
  - duct, 94
  - of intestines, 456
  - of kidneys, 534
  - of larynx, 361
  - of nasopharynx, 344
  - of nose, 344
  - pathology of, 93
  - of penis, 598
  - of rectum, 639
  - of skin, 190
  - of trachea, 361

Papilloma of ureters, 545
  of urethra, 594
  villous, 94
Papular syphilide, 70
Paracentesis, 392
Paralysis of bladder, 577
  of brachial nerves, 275
  congenital spastic, 293
  of facial nerves, 274
  fractures and, 707
  infantile, 279
  ischæmic, fractures and, 705
  muscular, following general anæsthesia, 163
Paraphimosis of penis, 597
Parasitic cysts, 104
Parasyphilitic affections, 71
Parathyroid glands, 327
Parenchymatous goitre, 325
  pancreatitis, 499
Paronychia, 178, 182
  septic, 182
  syphilitic, 182
Parotid gland, abscess of, 317
    treatment of, 317
  inflammation of, 317
    treatment of, 317
  tumors of, 324
Partial gastrectomy, 460
Pasteur treatment in hydrophobia, 53
Patella, dislocations of, 802
    diagnosis of, 802
    inward, 802
    outward, 802
    by rotation, 802
    treatment of, 802
  fractures of, 763
    diagnosis of, 764
    prognosis of, 765
    treatment of, 764
Patent urachus, 557
Pelvis, fractures of, 726
  inflammations of, 595
  injuries of, 595
Penis, cellulitis of, 595
  chancre of, 596
  chancroid of, 596
  contusions of, 595
  diseases of, 595
  epithelioma of, 598
    treatment of, 599
  operations on, 624
  papilloma of, 598
    treatment of, 599
  paraphimosis of, 597
  phimosis of, 596
    circumcision in, 597
    treatment of, 597
  sarcoma of, 599
  tumors of, 598
    treatment of, 599
  wart horns of, 598
Penis, wounds of, 595
Penoscrotal hypospadias, 579
Perforative appendicitis, acute, 473
Pericardium, wounds of, 198
    treatment of, 198
Perineal dislocation, 800
  hernia, 811
  hypospadias, 579
  prostatectomy, 626
Perinephritic abscess, 525
    symptoms of, 525
    treatment of, 526
Perinephritis, 525
  symptoms of, 525
  treatment of, 526
Periosteal sarcoma of bones, 665
Periostitis, 650
  suppurative, 654
Peripheral sarcoma of bones, 665
Periproctitis, 633
  symptoms of, 633
  treatment of, 633
Peripyloritis, 443
  symptoms of, 443
  treatment of, 443
Peritoneal sepsis, 425
Peritoneum, actinomycosis of, 430
    treatment of, 431
  diseases of, 423
  inflammation of, 423
  tuberculosis of, 428
    ascitic, 428
    caseating, 428
    diagnosis of, 429
    symptoms of, 428
    treatment of, 429
Peritonitis, acute, 423
    prognosis of, 425
    symptoms of, 424, 425
    treatment of, 426
  chronic, 430
  diffuse, 424
  local, 423
  spreading, 424
Peritonsillar abscess, 345
    treatment of, 345
Peroneal artery, ligation of, 229
Pes cavus, 869
Phagedenic chancroid, 596
  ulcers of skin, 186
Phalanges of foot, dislocations of, 809
      diagnosis of, 809
      treatment of, 809
    fractures of, 770
      diagnosis of, 771
      treatment of, 771
  of hand, dislocations of, 795
    fractures of, 750
      treatment of, 750
Phalanx of thumb, dislocations of, 795, 796
Pharyngotomy, Cheever's lateral, 352

Pharyngotomy, subhyoid, 374
Pharynx, angioma of, 362
  bacteria of, 22
  carcinoma of, 361
  diseases of, 344
  epithelioma of, 361
  gumma of, 350
  lipoma of, 362
  myoma of, 362
  operations on, 350, 363
  sarcoma of, 362
  tumors of, 361
    diagnosis of, 362
    treatment of, 362
  wounds of, 314
Phelp's splint in treatment of fractures of femur, 759
Phimosis of penis, 596
    circumcision in, 597
Phlebitis, 212
  diagnosis of, 212
  infective, 212
  plastic, 212
  suppurative, 212
  treatment of, 213
Phloridzin test in operations on kidneys, 546
Pia, inflammation of, 285
Piles, external, 644
  inflamed, 644
  internal, 644
  mixed, 644
  thrombotic, 644
Pirogoff's operation, amputation at ankle-joint, 854
Plaster-of-Paris bandage, 143
Plastic phlebitis, 212
Pleura, diseases of, 377
  injuries of, 377
Pneumaturia, 579
Pneumectomy, 396
Pneumococcus, 42
  acute osteomyelitis and, 650
Pneumothorax, 378, 381
  artificial, establishment of, 392
  closed, 381
  open, 381
  symptoms of, 381
  treatment of, 381
Poisoning, chloroform-, 120
    following general anæsthesia, 162
Polycystic kidneys, 53
Polydactylism, 875
Polyps of urethra, 594
Polypus, fibrous, 341
  nasal, 340
  nasopharyngeal, 341
Popliteal artery, ligation of, 228
Portal thrombosis, appendicitis and, 482
Post-rectal dermoids, 639
Pott's disease, 686
    symptoms of, 687
    treatment of, 688
  fracture, 767
    diagnosis of, 767
    prognosis of, 768
    treatment of, 768
Precipitins, 31
Pre-senile gangrene, 61
Primary hemorrhage, 113
Proctitis, 632
  symptoms of, 632
  treatment of, 632
Proctoscope, Kelly's, 636
Prolapse of rectum, 648
Prolapsus ani, 648
  recti, 648
Properitoneal hernia, 823
Prostate gland, calculus of, 617
  carcinoma of, 622
    operations for, 629
    prognosis of, 623
    symptoms of, 623
    treatment of, 623
  diseases of, 614
  exposure of, 625
  inflammation of, 614
  operations on, 626
  sarcoma of, 624
  senile hypertrophy of, 618
    Bottini operation, 622
    catheterism in, 621
    diagnosis of, 619
    prostatectomy in, 622
    symptoms of, 619
    treatment of, 619
  tuberculosis of, 617
    diagnosis of, 617
    treatment of, 617
  tumors of, 622
Prostatectomy, 626
  perineal, 626
  in senile hypertrophy of prostate gland, 622
  suprapubic, 626
Prostatitis, acute, 614
    diagnosis of, 615
    treatment of, 616
  chronic, 617
    diagnosis of, 617
    treatment of, 617
  diffuse, 615
  follicular, 615
  suppurative, 615
Prostration from heat, 122
Pruritus ani, 639
Psammomata, 90, 102
  of spinal cord, 308
Pseudo-arthrosis, fractures and, 707
Pseudohermaphrodism, 579

Pseudoparalysis, syphilitic, 682
Psoas abscess, 687
        diagnosis of, from femoral hernia, 820
Pubic dislocation, 798, 799
Pulmonary irritation following general anæsthesia, 162
Pulpy degeneration of joints, 683
Pulsating angioma, 204
Punch fractures, 750
Punctate hemorrhage of spinal cord, 305
Purulent exudation, 36
Pus, 39
Pustulocrustaceous syphilide, 71
Pyæmia, 42
Pyelitis, 521
    symptoms of, 522
    treatment of, 522
Pyelonephritis, suppurative, 522
        symptoms of, 523
        treatment of, 524
Pylorectomy, 460
    Mayo's method of, 462
Pyloric stenosis, 439
        diagnosis of, 440
        symptoms of, 439
        treatment of, 441
Pyloroplasty, 460
    Finney's method of, 460
Pylorus, dilatation of, digital, 460
        instrumental, 460
Pyogenic cocci, 22
Pyonephrosis, 524, 542
    symptoms of, 524
    treatment of, 524
Pyothorax, 382
    symptoms of, 383
    treatment of, 384

R.

Rachitis, 662
    symptoms of, 662
    treatment of, 662
Racket-shaped method of amputations, 842
Radial artery, ligation of, 225
Radiocarpal articulation, dislocations of, 793
Radius, dislocations of, 790, 792
    lower extremity of, fractures of, 742
            diagnosis of, 743
            treatment of, 743
Ranula, 347
    pancreatica, 502
    treatment of, 348
Raynaud's disease, 61
Rectal anæsthesia, 168
Rectum, adenocarcinoma of, 640
    adenoma of, 639
Rectum, angioma of, 639
    carcinoma of, 640
        diagnosis of, 641
        symptoms of, 641
        treatment of, 642
    congenital malformations of, 631
        stricture of, 631
            treatment of, 631
    cysts of, dermoid, 639
            post-rectal, 639
            thyrodermoid, 640
            treatment of, 640
    epithelioma of, 640
    fibroma of, 639
    inflammation of, 632
    lipoma of, 639
        symptoms of, 639
        treatment of, 639
    myxoma of, 639
    papilloma of, 639
    prolapse of, 648
        diagnosis of, 648
        treatment of, 648
    rupture of, 632
    sarcoma of, 641
        diagnosis of, 641
        treatment of, 642
    stricture of, 635
        fibrous, 635
        inflammatory, 635
        symptoms of, 635
        treatment of, 635
    tumors of, 639, 640
    ulcers of, 636
        actinomycotic, 637
        chancroidal, 637
        non-specific, 637
        simple, 637
        symptoms of, 637
        syphilitic, 637
        treatment of, 638
        tuberculous, 637
    wounds of, 631
Recurrent hemorrhage, 113
Removal of astragalus, 695
    of breast, 413
    of floor of mouth, von Langenbeck's operation for, 352
    of lower jaw, 353
    of palate, von Langenbeck's operation for, 352
    of tongue, 350
        von Langenbeck's operation for, 352
    of upper jaw, 353
Renal artery, aneurism of, 514
        symptoms of, 514
        treatment of, 514
    calculus, 529
        causes of, 530
        diagnosis of, 533
        prognosis of, 533

Renal calculus, symptoms of, 530
    treatment of, 533
    varieties of, 530
  suppuration, 517
    ascending infection, 517
    diagnosis of, 520
    hematogenous infections, 518
      acute unilateral, 519
    prognosis of, 520
    treatment of, 520
Resection of cervical sympathetic nerve for exophthalmic goitre, 274
      for glaucoma, 274
  of chest wall, osteoplastic, 395
  of liver, 494
  of ribs, 394
Resolution, 36
Respiratory anthrax, 54
  passages, bacteria of, 22
Retention cysts, 103
  of urine, 576
Retropharyngeal abscess, 346, 687
    treatment of, 346
Rhabdomyoma, 92
Rheumatic arthritis, 680
Rheumatoid, 680
Rhinitis, acute, 337
  chronic, 337
Rhinophyma, 340
  treatment of, 340
Rhinoplasty, 335
Ribs, chondroma of, 380
    treatment of, 381
  dislocations of, 783
  fractures of, 725
  osteoma of, 380
  osteomyelitis of, 379
    treatment of, 380
  resection of, 394
  tumors of, 380
Richter's hernia, 819
Rickets, congenital, 661
Riva-Rocci manometer, 112
Rodent ulcer, 99, 188
    pathology of, 99
Roller bandage, 135
Roseola, syphilitic, 70
Roux's operation, amputation at ankle-joint, 854
Rupial syphilide, 71
Rupture of bladder, 553
    extraperitoneal, 553
    intraperitoneal, 553
  of muscles, 245
  of rectum, 632
  of tendons, 245
  of urethra, 581

S.

Sacculated aneurism, 200
Sacro-iliac disease, 698
    symptoms of, 698
    treatment of, 698
Saddle-nose, 335
Salivary glands, carcinoma of, 324
    endothelioma of, 324
    inflammation of, 346
Saphenous varix, diagnosis of, from femoral hernia, 820
Sapræmia, 42
Sarcoma, 88
  of abdominal wall, 423
  of bladder, 572
  of bones, 664
    central, 665
    medullary, 665
    peripheral, 665
    periosteal, 665
  of breast, 407
  of eyeball, 324
  giant-celled, 90
  of gums, 349
  of intestines, 457
  of jaws, 349
  of kidneys, 535
  of liver, 486
  of lungs, 390
  of lymph-nodes, 244
  of mediastinum, 391
  of muscles, 249
  of nasopharynx, 344
  of neck, 324
  of nose, 344
  of œsophagus, 362
  of palate, 349
  pathology of, 88
  of penis, 599
  of pharynx, 362
  of prostate gland, 624
  of rectum, 641
  round-celled, 89
  of skin, 189, 193
  of spinal cord, 308
  spindle-celled, 89
  of spleen, 505
  of stomach, 446
  of suprarenal glands, 537
  of testicle, 611
  of thorax, 380
  of thyroid gland, 327
  of tonsils, 349
  of ureters, 545
Sarcomatosis cutis, 193
Scalds, 170
Scalp, adenoma of, sebaceous, 318
  cellulitis of, 316
  contusions of, 312
  cysts of, dermoid, 318
    sebaceous, 318

Scalp, hæmatoma of, 312
    treatment of, 312
  inflammations of, 316
  lipoma of, 322
  wounds of, 312
Scaphoid, fractures of, 749
    symptoms of, 749
    treatment of, 749
Scapula, fractures of, 728
    acromion, 728
    body of, 729
    coracoid, 730
    glenoid, 729
    neck of, 729
    spine of, 729
Schede's operation for empyema, 395
Schleich's method of infiltration anæsthesia, 165
Sciatic artery, ligation of, 227
  dislocation, 798, 799
  hernia, 811, 824
  stretching of nerves in, 263
Scirrhous carcinoma, 96
    of breast, 409
Sclerosis of bones, 658
  senile gangrene and, 60
Scoliosis, 857
  symptoms of, 857
  treatment of, 858
Scorbutic ulcers of skin, 187
Scrofuloderma of neck, 329
Scrotal hernia, 815
Scrotum, cellulitis of, 595
  contusions of, 595
  cysts of, dermoid, 598
    sebaceous, 598
  diseases of, 595
  epithelioma of, 599
    treatment of, 600
  inflammations of, 595
  injuries of, 595
  lipoma of, 598
  tumors of, 598
    treatment of, 599
  wounds of, 595
Sebaceous adenoma of scalp, 318
  cysts, 103
    of scalp, 318
    of scrotum, 598
    of skin, 190
  epithelioma, 99
Secondary hemorrhage, 113
Semilunar bone, dislocations of, 794
      treatment of, 794
  cartilages, dislocations of, 805
      diagnosis of, 805
      treatment of, 805
Seminal vesicles, exposure of, 625
    inflammation of, 613
      symptoms of, 614
      treatment of, 614
      tuberculosis of, 614
Seminal vesiculitis, 613
    symptoms of, 613
    treatment of, 614
Senile gangrene, 60
  hypertrophy of prostate gland, 618
        Bottini operation in, 622
        catheterism in, 621
        prostatectomy in, 622
  parenchymatous hypertrophy of breast, 404
Sepsis, acute general, 42
      prognosis of, 44
      symptoms of, 43
      treatment of, 44
  peritoneal, 425
Septic intoxication, 42
Septicæmia, 42
Serous cysts, 103
    of kidneys, 536
Serpiginous syphilide, 71
Shock, 106
  etiology of, 108
  experiments in, Blum's, 107
    Crile's, 107
    Eisemann's, 107
    Goltz's, 106
  prognosis of, 110
  symptoms of, 109
  treatment of, 110
Shoulder, dislocations of, 783
    causes of, 783
    complications of, 785
    diagnosis of, 785
    incomplete, 784
    intracoracoid, 784
    McBurney's hook in, 789
    old, reduction of, 788
    reduction of, by extension, 786
      Kocher's method of, 786
    subclavicular, 784
    subcoracoid, 784
    subglenoid, 784
    subspinous, 785
    supracoracoid, 785
    symptoms of, 785
    treatment of, 786
    varieties of, 784
  tuberculous arthritis of, 696
      amputation in, 698
      excision in, 696
Shoulder-joint, amputation at, 846
    deltoid flap-method, 847
    racket-shaped incision, 847
Sigmoid, acute diverticulitis of, 454
  chronic diverticulitis of, 455
Sigmoidoscope, 636
Sinus, 40
  frontal, inflammation of, 339

- Sinus, sphenoidal, inflammation of, 340
  - thrombosis, 288
    - symptoms of, 289
    - treatment of, 289
- Sinuses of brain, thrombosis of, 289
- Skey's operation, amputation at tarsometatarsal-joint, 855
- Skin, abrasion of, 184
  - actinomycosis of, 79
  - bacteria of, 20
  - carcinoma of, 193
  - contusions of, 172
    - treatment of, 173
  - dermoid cysts of, 191
  - diseases of, 170
  - epithelioma of, 186
  - excoriation of, 184
  - fibromata of, 191
    - hard, 191
    - soft, 191
  - fibroneuromata of, 191
  - inflammation of, 173
  - injuries to, 170
  - papilloma of, 190
  - sarcoma of, 193
    - idiopathic multiple hemorrhagic, 193
    - primary, 193
    - secondary, 193
  - sebaceous cysts of, 190
      - treatment of, 191
  - ulcers of, 184
    - carcinomatous, 189
    - chronic, 186
    - circulatory, 185
    - epithliomatous, 188
    - exuberant, 186
    - fungating, 186
    - healing, 186
    - indolent, 186
    - infective, 185
    - inflamed, 186
    - Marjolin's, 188
    - phagedenic, 186
    - rodent, 188
    - sarcomatous, 189
    - scorbutic, 187
    - sloughing, 186
    - spreading, 186
    - syphilitic, 187
    - traumatic, 186
    - treatment of, 189
    - trophic, 186
- Skin-flap method of amputations, 840
  - and muscle-flap method of amputations, 841
- Skin-grafting, 194
  - methods of, Reverdin's, 194
    - Thiersch's, 194
    - Wolfe's, 195
- Skull, fractures of, 714
- Skull, fractures of, circumscribed, 714
    - fissured, 714
  - osteoplastic resection of, 302
- Sling, 142
- Smith clamp, 647
- Somnoform as general anæsthetic, 163
- Soot-wart, 599
- Spastic paralysis, congenital, 293
- Spermatic cord, torsion of, 606
- Sphenoidal sinus, inflammation of, 340
- Spheroidal-celled carcinoma, 96
- Spica bandage, 136
- Spina bifida, 309
    - occulta, 309
  - ventosa, 656
- Spinal anæsthesia, 166
  - cord, chondroma of, 308
    - concussion of, 304
      - diagnosis of, from hysteria, 304
        - from traumatic neurasthenia, 304
    - contusion of, 304
    - crushing lesions of, incomplete, 307
        - symptoms of, 306
        - transverse, 306
        - treatment of, 307
    - diseases of, 304
    - endothelioma of, 308
    - exostosis of, 308
    - fibroma of, 308
    - fracture of, 305
    - gumma of, 308
    - hemorrhages of, 305
      - extradural, 305
      - intramedullary, 305
      - punctate, 305
      - subdural, 305
    - hernia of, 309
    - injuries of, 304
    - lipoma of, 308
    - myxoma of, 308
    - operations on, 308, 311
    - psammomata of, 308
    - sarcoma of, 308
    - syphilis of, 308
    - tuberculosis of, 308
    - tumors of, 308
      - prognosis of, 309
      - symptoms of, 308
      - treatment of, 309
    - wounds of, 305
- Spine, curvature of, rotary lateral, 857
        - symptoms of, 857
        - treatment of, 858
  - dislocations of, 779
    - atlas of, 722
    - axis of, 722
    - bilateral, 780
    - cervical vertebræ, 722
    - diagnosis of, 780

Spine, dislocations of, dorsal vertebræ, 722
        prognosis of, 781
        treatment of, 781
        unilateral, 780
    fracture-dislocations of, 722
    fractures of, 721
        atlas of, 722
        axis of, 722
        cervical vertebræ, 722
        dorsal vertebræ, 722
    of scapula, fractures of, 729
Spiral reversed bandage, 135
Spirochæte pallida, 69
Spleen, abscess of, 504
        symptoms of, 505
        treatment of, 505
    cysts of, 505
        echinococcus, 505
    diseases of, 504
    ectopic, 504
        diagnosis of, 504
        symptoms of, 504
        treatment of, 504
    endothelioma of, 505
    hypertrophy of, 506
        treatment of, 506
    lymphosarcoma of, 505
    operations on, 507
    sarcoma of, 505
    tuberculosis of, 505
    tumors of, 505
Splenectomy, 507
Splint, Dupuytren's, 769
Spondylitis deformans, 681
    tuberculous, 686
        symptoms of, 687
        treatment of, 688
Spondylolisthesis, 859
    symptoms of, 859
Sprains of joints, 669
Squamous-celled carcinoma, 98
Staphylococcus epidermidis albus, 21
    pyogenes albus, 20, 22
        aureus, 20, 22, 42
            acute osteomyelitis and, 650
Staphylorrhaphy, 332
Status lymphaticus, 123
        symptoms of, 123
Stenosis, pyloric, 439
Stenson's duct, wounds of, 313
Sternal end of clavicle, dislocations of, 777
Sternum, dislocations of, 782
    ensiform, dislocations of, 783
            symptoms of, 783
            treatment of, 783
    fractures of, 724
    manubrium, dislocations of, 782
            symptoms of, 782
            treatment of, 782
Stokes' method of amputation at knee-joint, 852
Stomach, acute dilatation of, following anæsthesia, 162
    bacteria of, 23
    carcinoma of, 443
        diagnosis of, 444
        prognosis of, 445
        symptoms of, 443
        treatment of, 445
    dilatation of, acute, 432
            diagnosis of, 433
            symptoms of, 433
            treatment of, 433
        congenital idiopathic, 433
                diagnosis of, 433
                prognosis of, 434
                treatment of, 434
    diseases of, 431
    foreign bodies in, 431
            symptoms of, 431
            treatment of, 431
    hour-glass, 442
    operations on, 459
    sarcoma of, 446
    tuberculosis of, 438
        symptoms of, 438
    ulcer of, 434
        prognosis of, 435
        symptoms of 435
        treatment of, 436
Stomatitis, gangrenous, 344
        prognosis of, 344
        treatment of, 344
Strangulated hernia, 812
        operations for, 833
Streptococcus, acute osteomyelitis and, 650
    pyogenes, 20, 22, 42
Streptothrix actinomyces, 75
Stricture of œsophagus, 357
    of rectum, 635
        congenital, 631
        fibrous, 635
        inflammatory, 635
    of ureters, 541
    of urethra, 587
Styptics, 116
Subacromial bursitis, 255
Subastragaloid dislocations, 807
        backward, 808
        diagnosis of, 808
        inward, 808
        outward, 808
        treatment of, 808
Subclavian artery, ligation of, 223
Subclavicular dislocation of shoulder, 784
Subcoracoid dislocation of shoulder, 784
Subcutaneous tissues, diseases of, 170
        injuries to, 170

Subdeltoid bursitis, 255
Subdural hemorrhage of spinal cord, 305
Subglenoid dislocation of shoulder, 784
Subhyoid pharyngotomy, 374
Submammary abscess, 399, 400
Subparietal injuries of kidneys, 510, 511
Subpectoral abscess, 379
Subperiosteal abscess, 651
Subphrenic abscess, 426
        appendicitis and, 482
Subspinous dislocation of shoulder, 785
Supernumerary fingers, 875
Suppuration, 38
    pus in, 39
Suppurative pancreatitis, 498
    periostitis, 654
    prostatitis, 615
    pyelonephritis, 522
Supracoracoid dislocation of shoulder, 785
Supracotyloid dislocation, 800
Suprapubic lithotomy, 567
    prostatectomy, 626
Suprarenal glands, cysts of, 537
        hypernephroma of, 537
        sarcoma of, 537
        tumors of, 534, 537
            symptoms of, 537
            treatment of, 537
    struma, 537
Sutures, 146
    button, 147
    chain-stitch, 146
    continued, 146
    Cushing, 146
    interrupted, 146
    lead plate, 147
    mattress, 146
    of nerves, 260
    quilled, 147
    subcuticular, 148
    through-and-through, 148
Syme's operation, amputation at ankle-joint, 854
Syndactylism, 874
Synovitis, 672
    acute serous, 673
            symptoms of, 673
            treatment of, 673
    chronic serous, 673, 674
            diagnosis of, 674
            treatment of, 675
Syphilide, macular, 70
    papular, 70
    pustulocrustaceous, 71
    rupial, 71
    serpiginous, 71
    tubercular, 71
    ulcerative, 71
Syphilis, 68
    acquired, 69
        recurrent eruptions in, 70
                papular, 70
                pustular, 70
                pustulocrustaceous, 70
                squamous, 70
        symptoms of, 69
            primary period, 69
            secondary period, 70
            tertiary period, 71
    of bones, 655
    of breast, 402
    congenital, 69
    diagnosis of, 71
    of epididymis, 609
    etiology, 69
    hereditary, 73
        symptoms of, 74
        treatment of, 75
    Hutchinson's teeth in, 75
    of kidney, 526
    of larynx, 363
    of lymph-nodes, 241
    of skin, 187
    of spinal cord, 308
    of testicle, 609
    treatment of, 72
Syphilitic arthritis, 682
    craniotabes, 75
    dactylitis, 656
    endarteritis, 71
    osteochondritis, 75, 656
    pseudoparalysis, 682
    roseola, 70
    ulcers of rectum, 637
Syringe, urethral, Keyes', 586
Syringomyelocele, 310

T.

Talipes, 867
    calcaneovalgus, 867
    calcaneus, 867, 869
    equinovarus, 867
    equinus, 867, 868
    valgus, 867, 868
    varus, 867
Tarsal bones, dislocations of, 809
            diagnosis of, 809
            treatment of, 809
        fractures of, 770
            diagnosis of, 770
            treatment of, 771
        tuberculous arthritis of, 696
Tarsometatarsal joint, amputation at, 854
            Hey's operation, 855
            Skey's operation, 855
T-bandage, 140
Teale's method of amputations, 842
Telangiectasis, lymphatic, 92

Temporal artery, ligation of, 223
Tendons, diseases of, 245
    dislocation of, 248
    inflammation of, 249
    injuries of, 245
    rupture of, 245
        diagnosis of, 245
        treatment of, 246
    tuberculosis of, 249
    wounds of, 246
Tenosynovitis, 249
    acute, 249
    chronic, 249
    subacute, 249
    symptoms of, 250
    treatment of, 250
Teratoma, pathology of, 99
    of testicle, 611
Terminal infections, 30
Testicle, adenoma of, 612
    carcinoma of, 611
    chorion epithelioma of, 612
    contusions of, 606
        symptoms of, 606
        treatment of, 606
    diseases of, 605
    ectopic, 605
        treatment of, 605
    fibrocystic disease of, 612
    hernia of, 606
    inflammation of, 608
    sarcoma of, 611
    syphilis of, 609
        diagnosis of, 609
        treatment of, 610
    teratoma of, 611
    tuberculosis of, 610
        diagnosis of, 610
        treatment of, 611
    tumors of, 611
        diagnosis of, 612
        mixed, 611
        prognosis of, 612
        treatment of, 612
    wounds of, 606
Tetanus, 47
    acute, 49
    cephalic, 49
    chronic, 49
    diagnosis of, 49
    etiology of, 47
    pathologic anatomy of, 48
    prognosis of, 50
    symptoms of, 49
    treatment of, 50
Thecal whitlow, 178
Thigh, amputation of, 851
Thomas' collar, 690
    splint in treatment of hip-disease, 692
        of tuberculous arthritis of knee, 694
Thompson's searcher, 565
Thoracoplasty, 394
Thoracotomy, 393
    anterior mediastinal, 396
    osteoplastic, 397
Thorax, abscess of, 379
    actinomycosis of, 77
    chondroma of, 380
        treatment of, 381
    contusions of, 377
        treatment of, 377
    diseases of, 377
    endothelioma of, 380
    injuries of, 377
    operations on, 392
    sarcoma of, 380
        prognosis of, 380
        treatment of, 378, 381
    tumors of, 380
    wounds of, 378
Thrombosis, ischæmic gangrene and, 61
    portal, appendicitis and, 482
Thumb, phalanx of, dislocations of, 795, 796
Thymic asthma, 123
Thyrodermoids, 640
Thyroglossal cysts, 321
    fistulæ, 321
Thyroid artery, inferior, ligation of, 224
        superior, ligation of, 223
    cartilage, complete section of, 363
    dislocation, 798, 799
    gland, adenoma of, 326
        carcinoma of, 327
        operations on, 327
        sarcoma of, 327
        tumors of, 324
            treatment of, 327
Thyroidectomy, 327
Thyrotomy, 363
Tibia, fractures of, 766
        diagnosis of, 767
        prognosis of, 768
        treatment of, 768
Tibial artery, anterior, ligation of, 228
        posterior, ligation of, 228
Tibiotarsal dislocations, 806
        backward, 807
        forward, 807
        outward, 807
        symptoms of, 807
        treatment of, 807
        upward, 807
Tic convulsif, 271
    douloureux, 264
Tissues, subcutaneous, diseases of, 170
        injuries to, 170
Toe-nail, ingrowing, 182
Toes, amputation of, 855

Tongue, carcinoma of, 348
        symptoms of, 348
    epithelioma of, 348
        prognosis of, 348
        treatment of, 348
    gumma of, 350
    inflammation of, 344
    operations on, 350
    removal of, 350
        von Langenbeck's operation for, 352
    tuberculosis of, 350
    tumors of, 348
Tonsillotome, Mackenzie's, 343
Tonsils, cellulitis of, 345
    enlarged, 342
        treatment of, 343
    enucleation of, 343
        Mathew's operation for, 343
    gumma of, 350
    inflammation of, 345
    removal of, von Langenbeck's operation for, 352
    sarcoma of, 349
    tumors of, 349
Torsion of spermatic cord, 606
Torticollis, 271
    treatment of, 272
Trabeculated bladder, 588
Trachea, adenoma of, 361
    carcinoma of, 361
    chondroma of, 361
    diseases of, 354
    fibroma of, 361
    foreign bodies in, 354
            treatment of, 355
    lipoma of, 361
    operations on, 364
    papilloma of, 361
    tumors of, 361
        diagnosis of, 362
        treatment of, 362
    wounds of, 314
Tracheal dilator, 364
    tube, 365
Tracheotomy, 364
    test, 366
Transfusion of blood, direct, 150
        author's method, 152
        Crile's method, 151
Traumatic aneurism, 201
        fractures and, 707
    cephalalgia, 293
    dislocations, 772
    epilepsy, 292
    gangrene, 62
    hemorrhage, 113
    neurasthenia, diagnosis of concussion of spinal cord from, 304
    osteomyelitis, acute, 650
    ulcers of skin, 185
Trephining, 301
Triangular bandage, 140
Trigger-finger, 251, 875
    treatment of, 875
Trophic ulcers of skin, 186
True aneurism, 199
Tubercles, 65
Tubercular syphilide, 71
Tuberculosis, 64
    bacillus of, 64
        distribution of, 65
    bacteriologic diagnosis of, 67
            intestinal discharges, examination of, 68
            serous exudate, examination of, 68
            sputum, examination of, 67
            urine, examination of, 68
    of bladder, 562
    of bones, 656
    of breast, 402
    cutis, 329
    etiology of, 67
    of fasciæ, 252
    of gastro-intestinal tract, 438
    histology of, 65
    ileocæcal, 438
    of intestines, 438
        hyperplastic, 438
    of kidney, 527
    of larynx, 363
    of lungs, 388
    of lymph-nodes, 235
    modes of infection in, 67
    of peritoneum, 428
        ascitic, 428
    of peritoneum, caseating, 428
    of prostate gland, 617
    of seminal vesicle, 614
    of skin, 187
    of spinal cord, 308
    of spleen, 505
    of stomach, 438
    of tendons, 249
    of testicle, 610
    of tongue, 350
    of various organs, occurrence of, 66
Tuberculous arthritis, 683
        amputation in, 686
        of ankle, 695
        arthrectomy in, 685
        of elbow, 696
            amputation in, 698
            excision in, 697
        of hip-joint, 691. *See* Hip-disease.
        of knee, 693
            amputation in, 695
            arthrotomy in, 694
            excision in, 694
        of shoulder, 696

Tuberculous arthritis of shoulder, amputation in, 698
        excision in, 696
    of tarsal bones, 696
    treatment of, 685
    of wrist, 697
        amputation in, 698
        excision of, 697
  dactylitis, 657
  spondylitis, 686
  ulcers of rectum, 637
Tubulodermoids, 105
Tumors, 81
  of abdominal wall, 423
  adrenal, 537
  of bladder, 571
    villous, 571
  of bones, 663
  of brain, 294
  of breast, 405
  of chest-wall, 380
  classification of, 84
  degenerations in, 83
  etiology of, 81
  of face, 318
  of gall-bladder, 493
  of gall-ducts, 493
  of gums, 349
  of head, 318
  innocence in, 82
  of intestines, 456, 457
  of jaws, 349
  of kidneys, 534
  of larynx, 361
  of liver, 486
  of lungs, 390
  malignancy in, 82
  of mediastinum, 391
  of mouth, 347
  of muscles, 249
  of nasopharynx, 340
  of neck, 318
  of nerves, 270
  of nose, 340
  of œsophagus, 361
  of palate, 349
  of pancreas, 503
  of parotid glands, 324
  of penis, 598
  of pharynx, 361
  of prostate gland, 622
  of rectum, 639, 640
  of ribs, 380
  of scrotum, 598
  of spinal cord, 308
  of spleen, 505
  of suprarenal gland, 534, 537
  of testicle, 611
  of thorax, 380
  of thyroid glands, 324
  of tongue, 348
  of tonsils, 349
Tumors of trachea, 361
  treatment of, 84
  of ureters, 545
  of urethra, 593
  varieties of, 84
Two-tailed jaw bandage, 141
Typhoid bacillus, acute osteomyelitis and, 650
  osteomyelitis, 654
  perforation of intestines, 437

U.

Ulcer, 38
  of duodenum, 434
  of foot, perforating, 273
  of intestines, 436
  of rectum, 636
    actinomycotic, 637
    chancroidal, 637
    non-specific, 637
    simple, 637
    syphilitic, 637
    tuberculous, 637
  of stomach, 434
  venereal, 596
Ulcerations, gummatous, 71
Ulcerative syphilide, 71
Ulna, dislocations of, 790
Ulnar artery, ligation of, 225
Umbilical fistulæ, congenital, 422
      treatment of, 422
  hernia, 811, 820
    congenital, 821
    operations for, 832
      Blake's, 832
      Mayo's, 833
    signs of, 821
Unilateral spine, dislocations of, 760
Urachus, patent, 557
Uræmia, 119
  etiology of, 119
  pathology of, 119
  symptoms of, 119
  treatment of, 119
Uranoplasty, 334
Ureteral calculus, 542
    prognosis of, 544
    symptoms of, 542
    treatment of, 545
Ureterectomy, 551
Ureteritis, 540
  symptoms of, 541
  treatment of, 541
Ureterotomy, 551
Uretero-ureterostomy, 551
Ureters, calculus of, 542
  cysts of, 545
  diseases of, 508, 540
  epithelioma of, 545
  implantation of bladder into, 552
  inflammation of, 540

Ureters, injuries of, 508, 540
  operations on, 545
  papilloma of, 545
  sarcoma of, 545
  stricture of, 541
    symptoms of, 541
    treatment of, 541
  tumors of, 545
    prognosis of, 545
    symptoms of, 545
    treatment of, 545
  wounds of, 540
    symptoms of, 540
    treatment of, 540
Urethra, calculus of, 593
  congenital absence of, 579
  contusions of, 581
  diseases of, 581
  epithelioma of, 593
    treatment of, 594
  inflammations of, 583
  injuries of, 581
  malformations of, 579
  papilloma of, 594
  polyps of, 594
  rupture of, 581
    symptoms of, 582
    treatment of, 582
  stricture of, 587
    diagnosis of, 589
    organic, 587
    spasmodic, 587
    symptoms of, 588
    treatment of, 589
  tumors of, 593
  wounds of, 581
Urethral syringe, Keyes', 586
Urethritis, acute, 583
    diagnosis of, 584
    prognosis of, 584
    symptoms of, 583
    treatment of, 585
  chronic, 586
Urethrometer, Otis', 588
Urethrotome, Otis-Wyeth, 592
Uric acid calculi, 564
Urine, incontinence of, 578
    in children, 578
  retention of, 576

V.

Vaginal saprophytes, 24
Valvular disease of heart, 121
Varicocele, diagnosis of, 600
    from inguinal hernia, 817
  symptoms of, 600
  treatment of, 601
Varicose aneurism, 201
  veins, 213
    diagnosis of, 216
    of leg, 213
Varicose veins, symptoms of, 216
    treatment of, 217
Varix, aneurismal, 201
  saphenous, diagnosis of, from femoral hernia, 820
Veins, diseases of, 212
  injuries to, 212
  varicose, 213
Velpeau bandage, 138
Venereal ulcer, 596
Venous angioma, 218
    treatment of, 219
  hemorrhage, 113
Ventral hernia, 811, 822
    operations for, 832
      Blake's, 832
      Mayo's, 833
Vertebræ, cervical, dislocation of, 722
    fractures of, 722
  dorsal, dislocation of, 722
    fractures of, 722
Vertebral artery, ligation of, 224
Villous papilloma, 94
Volvulus, 447
von Langenbeck's operation for removal of floor of mouth, 352
      of palate, 352
      of tongue, 352
      of tonsils, 352

W.

Wart horns of penis, 598
Warts, 93
Weak foot, 870
Weaver's bottom, 256
    treatment of, 256
Webbed fingers, 874
Weeping sinew, 251
Wet dressings, 144
Whitehead's mouth-gag, 334
  treatment of hemorrhoids, 648
Whitman's method in treatment of fractures of femur, 756
  splint in treatment of hip-disease, 692
Wilson' sempyema drainage-tube, 382, 383
Wool-sorters' disease, 53
Wound of abdomen, 418
  of bladder, 553
  of chest-wall, 378
  closure of, methods of, 145
  dressings, 143
    cigarette drain in, 144
    glass drainage-tube in, 144
  of face, 313
  of joints, 671
  of kidneys, open, 510, 513
  of larynx, 314
  of muscles, 246

Wound of neck, 313
  of nerves, 257
  of penis, 595
  of pharynx, 314
  of rectum, 631
  of scalp, 312
  of scrotum, 595
  of spinal cord, 306
  of Stenson's duct, 313
  of tendons, 246
  of testicle, 606
  of thorax, 378
  of trachea, 314
  treatment of, 126
    antiseptic, 126
    aseptic, 127
    preparation of instruments in, 128
      nurses in, 127
      operator in, 127
      patient in, 127
      sutures in, 128
  of ureters, 540
  of urethra, 581
Wrist, amputations at, 845
  carpometacarpal articulation, dislocation of, 794
  dislocations of, 793
Wrist, fractures of, 745
    complications of, 746
    diagnosis of, 746
    prognosis of, 747
    treatment of, 747
  inferior radio-ulnar articulation, dislocations of, 793
  radiocarpal articulation, dislocations of, 793, 794
  tuberculous arthritis of, 697
      amputation in, 698
      excision of, 697

X.

Xanthine calculi, 564
X-ray dermatitis, 173

Y.

Yaws, 184
Young's operation for carcinoma of prostate, 629
  prostatic tractor, 627

Z.

Zygoma, fractures of, 719